ELECTRICAL ENGINEERING

NOVEMBER 1960
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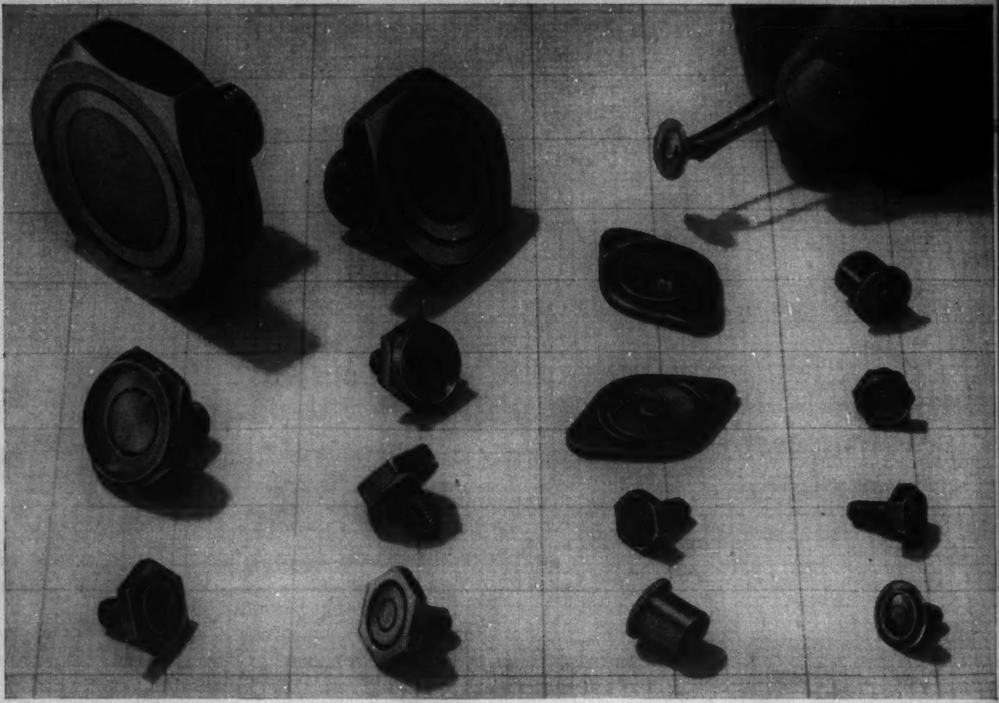

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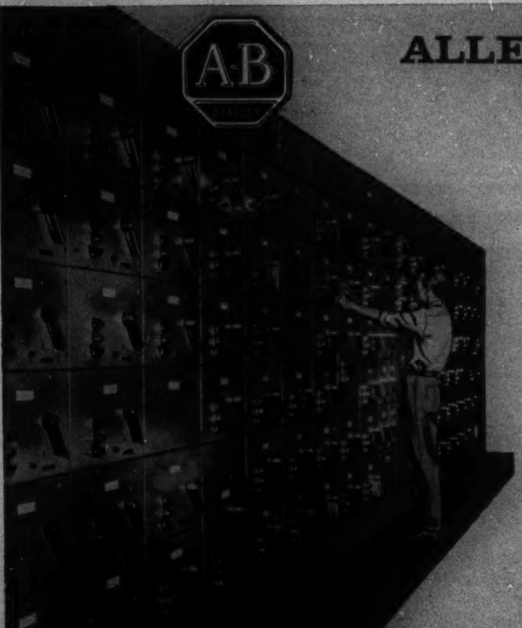

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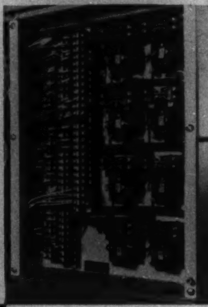

This shows A-B Bulletin 700 control relays mounted in an A-B control center unit.

A-B control centers can be equipped with a wide variety of components. These Bulletin 849 timers are used on an automatic conveyor line.

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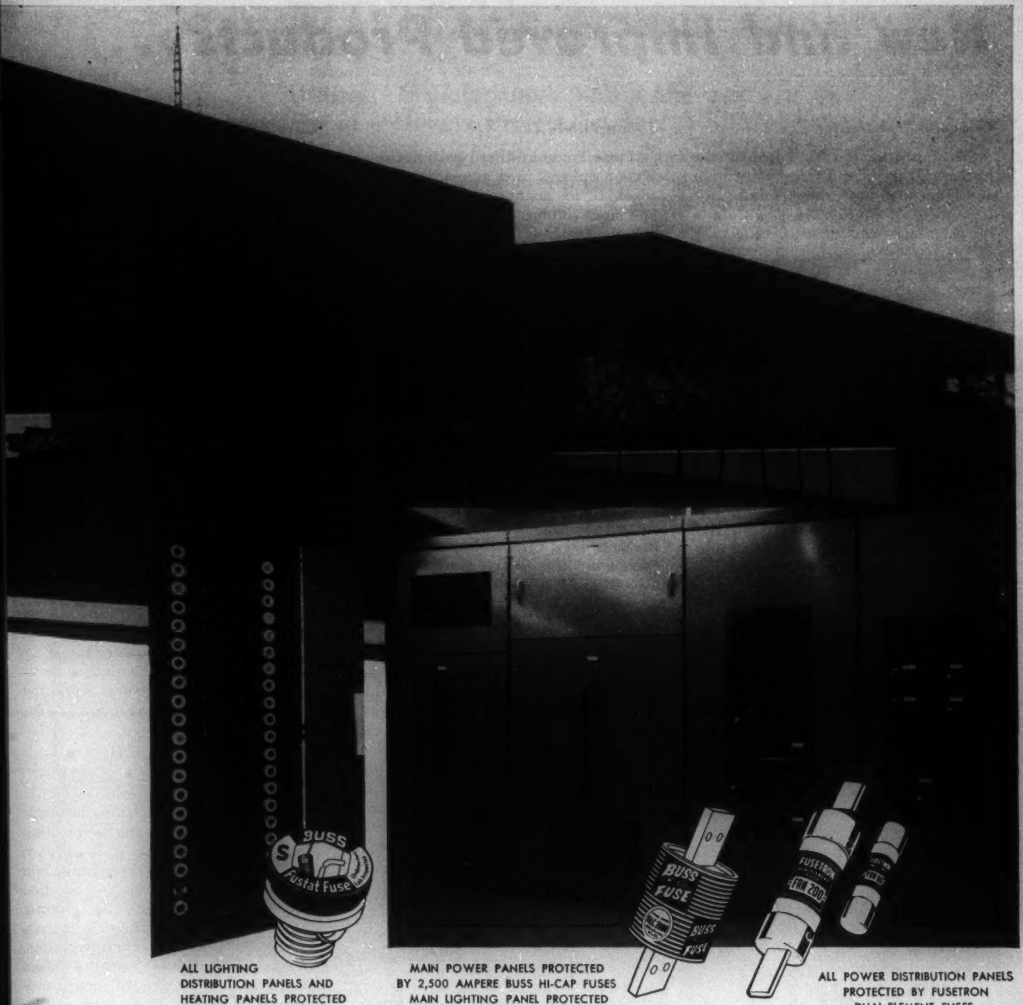

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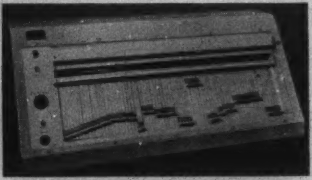
New and Improved Products . . .

Telecode Transmitter . . .

Developed for the Air Force for use in the *433L* system to transmit weather and flight plan data, the semiautomatic transmitter is equipped with 72 movable character switches side by side, each capable of being set at any of 52 alphabetic, numeric, or special type D Teletype code signals. To transmit the prearranged message, a button is pushed on the panel. A pulse can also be sent from a remote Teletype station to interrogate the transmitting station. *Wang Labs., Inc., 12 Huron Dr., Natick, Mass.*



Position Control . . .

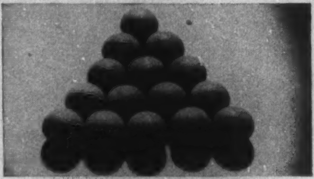
A new point-to-point machine positioning control called RAPAC has been developed to provide accuracy of ± 0.001 inch and repeat accuracy to ± 0.005 inch. Utilizing punched tape for predetermining sequences, the system does not require special machine designs. It will operate with virtually any precision machine tool or device requiring accurate positioning. Static components and encapsulated buildblock circuitry are used wherever possible to reduce and simplify maintenance. *Square D Co., Dept. SA, 4041 N. Richards St., Milwaukee 12, Wis.*

Selector-Counter . . .

A new, fully automatic, electronic selector and counter for conveyor line use optically selects and counts coded container items for discharge or routing. Up to 31 different types of containers can be individually sorted and counted from one conveyor line. With this system it is possible to automate warehouses and production lines where large numbers of different types of containers must be handled. The counting feature is useful for federal tax, customer billing, and production rate purposes, while the simultaneous counting feature permits the selector-counter to be used for inventory control work while selective routing is being made. *Atronic Products Inc., 1 Bala Ave., Bala-Cynwyd, Pa.*

Teflon Fillers . . .

These are not billiard balls but solid Teflon spheres used as spacer or filler material to maintain at low cost a specified volume of liquid in a container. Available in a wide range of diameters, the fillers are useful where it is desirable to maintain a large volume of a relatively expensive liquid. This inert material can also be used to control the volume of oil used in circuit breakers and transformers. *Garlock Electronic Products, Garlock Inc., Camden 1, N. J.*

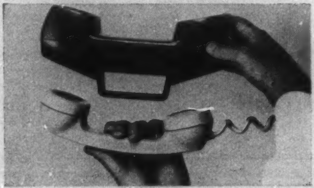


Sensing Device . . .

Ultrasonic sound waves rather than light waves are used to operate this automatic control and switching device called Sonac. Unlike photoelectric beams, ultrasonic waves are unaffected by vibration, smoke, dust, or varying light conditions. Flexibility of installation is readily achieved because sonic waves can be piped through a tube to fit difficult functional needs. *Aro Equipment Corp., Bryan, Ohio.*

Voice Scrambler . . .

Using a 10-transistor circuit with internal batteries for power, this portable security voice scrambler can be used anywhere by merely holding the device to an ordinary telephone. There are no wires or other connections between the two instruments. The gibberish is transmitted over the regular phone circuit and only a second security phone attachment at the receiving end will translate it back into normal speech. *Delcon Corp., Palo Alto, Calif.*



Circuit Tester . . .

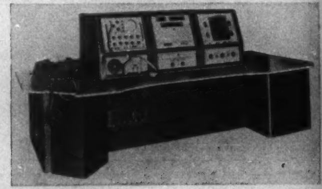
Capable of testing 167 related circuits simultaneously against all others, or one nonrelated circuit at a time, this semiautomatic instrument was designed to test insulation and high-voltage leakage breakdowns in electronic components, cables, wire harnesses, and complete assemblies. Also adaptable for programming to customer requirements, the *T-660* provides for a variable voltage test adjustment from 100 to 1,000 volts, and from 1,000 to 2,000 volts potential. *Trans-American Dynamics Corp., 149-A Babylon Tpke., Roosevelt, L. I., N. Y.*

2-Way Pocket Radio . . .

Operating under the 27 megacycle citizens' band that requires no operating license or permit, this low-cost, fully transistorized 2-way shirt pocket radio can be used anywhere and by anyone requiring reliable short-range communication. Depending on application and terrain, a reasonable range in open country is 2 to 3 miles, while in a crowded city among steel buildings the range is 1 or 2 blocks. *Ross Labs., Inc., Seattle, Wash.*

Test Station . . .

Complete test routines can be made with this automatic, centralized station where the entire test procedure is under the control of prepared punched tape. Stimuli are selected and applied to the object under test. The response is measured and digitalized and then compared against programmed limits. Measured input and output values with evaluation results are then simultaneously printed onto paper. The system can measure alternating and direct voltage or current amplitudes, ratios, frequencies, impedance, and events-per-unit time. *Consolidated Avionics Corp., 800 Shames Dr., Westbury, N. Y.*



(Continued on page 26A)

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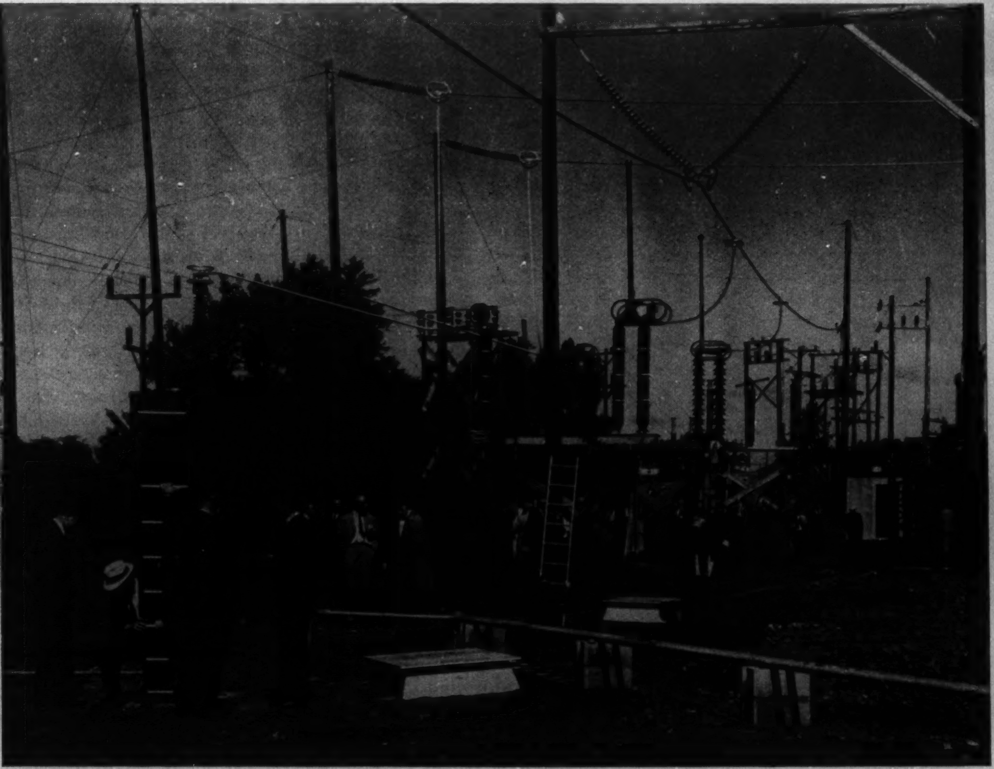
New EHV Cable Testing Facility

Utilities, Manufacturers, and a University Co-operate in a Unique Project To Test 500-Mva Cable

SEPTEMBER 14, 1960, marked the dedication of a new ehv (extra-high-voltage) cable testing station at Cornell University. Inasmuch as the utility load doubles about every 8 years, rights of way become more difficult to obtain, and station units are larger, the need to develop 500-mva cable was foreseen in 1953.

A co-operative project was agreed upon by the electric utilities, represented by the Association of Edison Illuminating Companies (AEIC) and the Edison Electric Institute (EEI); four cable manufacturers, namely, Anaconda Wire and Cable Company, General Cable Corporation, Phelps Dodge Copper Products Corporation and The Okonite Company; two terminal manufacturers, G and W Electric Specialty Company and Ohio Brass Company, and one pressurizing equipment manufacturer, Jerome Hydraulics Company. The combined manufacturer-user cost of this project has been estimated to be approximately $3 million.

The dedication ceremonies were opened by L. I. Komives, chairman, Joint AEIC-EEI Manufacturers Extra-High-Voltage Cable Project Steering Committee; followed by D. R. Corson, dean of the College of Engineering, who spoke from the educational point of view. Each of the four large cable manufacturers who supplied test samples described the designs and manufacturing procedures. C. S. Schifreen, chairman of the AEIC Cable Engineering Section, paid tribute to some 21 other electric equipment and service manufacturers who had donated or loaned apparatus for the project. After the talks presented herewith, Prof. J. L. Rosson



Visitors inspect the ehv cable testing facility at Cornell University.

345-kv air-break disconnect switch between test bus and high-voltage standard capacitor.

energized the station, completing the first phase of this project; and those attending inspected the facilities.

The second phase of the project will probably require a period of 3 years which involves energizing the systems. During the first 2 years, the voltage will be raised in gradual steps from 345,000 volts to 415,000 volts with loading temperatures comparable to commercial operating conditions. Following the 2-year period will be tests at elevated temperatures and voltages up to 500,000 volts in order to further determine the characteristics of the systems.

OPENING REMARKS

THE MEMBERS of the Steering Committee, the Association of Edison Illuminating Companies, and the Edison Electric Institute appreciate your coming to the opening of the extra-high-voltage cable testing station on the campus of Cornell University. The Joint AEIC-EEI-Manufacturers Steering Committee spent much time and effort on this project during the past 5 years or so. The organizations and participating electric power companies are sponsoring this project. Allow me to say just a few words in the name of the investor-owned electric power companies, whose foresightedness and good business sense made it possible for our vision of a few years back to become a reality. We are celebrating today the completion of the first phase, the building of the testing station. The second phase of our work, testing, can now begin. We hope that when this second phase is completed, perhaps 3 years hence, sufficient meaningful data will be accumulated on which the third phase of the work, evaluation of the test results, may proceed in an acceptable manner.

We celebrate here today the materialization of the first extra-high-voltage cable testing station in the world, conceived, developed, and built by private enterprise. Users and manufacturers of electric equipment are working together here with an institute of advanced learning to lay the foundation for future progress through those studying here. The voluntary co-operation of private companies we feel is the American way of solving problems too large for one company to attack, in contrast with other parts of the world where the government is expected to step in and handle projects of this magnitude.

You will hear from the other two branches in this enterprise later. Let me assure you the investor-owned electric power companies feel that this project is timely and necessary because of the problems we are facing, and that we have already received our first dividend. We shall energize the station today, but not the cable samples because of unforeseen difficulties which make it prudent first to find out and correct certain conditions. These difficulties which have arisen prove, better than any words of mine can describe, the need for this project where electric equipment such as samples of cable and accessories can be tested under as nearly as possible field conditions, impractical in the laboratory.

As the Chairman of the Steering Committee, I feel that I owe a debt of gratitude to my fellow committee members, both from utilities and manufacturers, who worked so hard to bring this project to fruition. Thanks are in order to our friends in the electrical manufacturing industry who have so generously donated equipment to make this station a reality. I would also like to express my appreciation to Prof. Rosson for his outstanding contribution, working day and night to make this project a success. He could not accomplish this without the backing of Cornell University whose understanding of the magnitude of the task has resulted in such splendid co-operation.

L. I. KOMIVES, Chairman, Joint AEIC-EEI
Manufactures Extra-High-Voltage Cable
Project Steering Committee

EDUCATIONAL ASPECTS

CORNELL UNIVERSITY is proud to participate in this truly co-operative research program. The combination that we have here of utility companies, cable manufacturers, together with the University, represents a type of co-operative venture that I have not had the privilege of working with previously.

This project is especially significant in view of this country's sky-rocketing power requirements, which are amplified by our rapidly expanding population. In this situation in which we find ourselves, all phases of energy generation, energy conversion, and energy distribution are of great importance.

There are two ways in which the University can make contributions to the program. In the first place, we train students, and one of our goals is to stimulate student interest in the power field. In the second place, our educational program requires a vigorous research effort. There are many places in the power area where we can work. In the cable research appropriate to this project, Cornell's participation is unusually appropriate. We have just undertaken the creation of a large-scale interdisciplinary Materials Science Center which will be concerned with basic understanding of materials problems important in a wide variety of engineering applications. We can do significant materials research in the engineering of molecules and atoms into better materials for cable insulation.

With the dedication of this project we are just beginning our work in this field.

D. R. CORSON, Dean, College of Engineering,
Cornell University.

GENERAL CABLE

GENERAL CABLE CORPORATION supplied high-pressure oil-filled pipe-type cable for the 345-kv Cornell field trial. The cable consists of single-conductor 2,000 MCM, copper concentric enameled strand, strand shielding, 1 inch of oil impregnated paper insulation, insulation shielding, moisture seal and shielding assembly, and a polyethylene skid wire over-all. Two such single-conductor cables making up a single-phase loop are installed in a 10.75-inch OD steel line pipe, the latter being filled with oil and maintained under a nominal 200-psig pressure with a pumping plant.

The cable for the Field Trial was manufactured on a newly installed 345-kv production line which is capable of insulating commercial lengths of 345-kv cable in a single pass through the machine. A number of new and novel features have been incorporated in the new production line. For example, the new taping heads are provided with such features as precalibrated springs for tape tension control, compensating means for maintaining tape tension constant independent of pad dimensions, automatic device to bring the machine to a stop before a tape runout occurs, provision for accelerating the speed of the machine at a predetermined rate from standstill to running speed, etc. In addition, the entire production line is housed in an enclosure provided with air-conditioning equipment capable of maintaining a constant relative humidity as low as 10%. The moisture content of the insulating paper is brought into equilibrium with the relative humidity selected for manufacture by passing the paper, in wide sheet form, through a series of heated rolls and then into a slitting room maintained at the selected relative humidity. Here the "jumbo" rolls are slit into pads and the latter then transported by way of an air-conditioned conveyor system to each taping-head location.

A still further novel feature of the new line is the "traversing take-up"—a take-up reel—which is mounted in a floor pit and is free to move in both a horizontal and vertical direction. The movement is so synchronized with that of the taping machine that the point on the take-up reel which the cable is to occupy is always directly in line with the axis of the caterpillar capstan and the taping heads, thus eliminating the more or less indeterminate bends and twists to which a cable in the dry (and hence in the least flexible state) is subjected in its movement back and forth across a conventional fixed position take-up reel. In the manufacture of the cable length for the field trial, a specially developed low-density wood pulp paper varying in thickness from 3 to 8 mils was employed and the taping machine enclosure was maintained at 10% relative humidity.

Because accelerated test studies on oil-filled cable have indicated that metals, and bare copper in particular, can have an important catalytic effect in the development of deleterious products when in contact with mineral oil at temperatures and electrical stresses of interest in high-voltage cable application, an effort has been made to keep direct contact between bare copper and oil to a minimum in the field trial. To accomplish this, a major portion of the individual wires of the concentrically stranded 2,000-MCM conductor have been coated with a thin layer of synthetic enamel. The excellent self-fluxing and solder-ability characteristics of this enamel make it feasible to remove the enamel from the

Prof. J. L. Rosson, Cornell University, energizes ehv cable test station.

individual wires by flushing with hot solder prior to application of a conventional pressed connector. Insofar as a-c/d-c resistance ratio is concerned, theory indicates and measurement confirms that enamelling of the strands eliminates proximity effect both "in air" and "in pipe." As a result, the over-all 3-phase "in pipe" a-c/d-c ratio for a 2,000-MCM concentric conductor with enameled strands has been found to be comparable to that for a 2,000-MCM compact segmental conductor.

In order to minimize bare copper-oil contact in the system as a whole, tinned copper, aluminum, stainless steel, or nonmetallic materials have been employed for shielding tape, skid wire, riser pipe, etc.

H. M. McGrath, Vice-President and
Chief Engineer.

OKONITE

In 1954, the AEIC Cable Engineering Section informed the power cable manufacturers that the utilities expected in about 5 years to require insulated cable for the transmission of at least 500-mva load at 345 kv. In view of the fact that at that time we did not have any cable operating at this voltage, the Association felt it was desirable that a prototype cable be furnished; they would install and subject it to field testing to prove in its capabilities. The Okonite Company agreed to participate in the investigation.

We were furnished the conditions under which the cable would be installed and the test requirements. The latter were quite severe. Not only would the cable be required to meet the primary operating conditions, but it was desirable to know how much better the cable might be, that is, how high an operating voltage the cable would withstand without showing instability and at how much higher temperature could the cable operate without showing instability. Both conditions are well worth knowing.

Perhaps we are being too conservative in the operating electric stress on which the cable design is based and, therefore, it might be possible to reduce the insulation thickness after finding out at how high an electric stress the cable can operate. Secondly, if we can increase the operating temperature, then we will be able to increase the power load that can be transmitted, which of course is desirable.

Never before has an opportunity such as this been presented to the cable manufacturers. In Europe at test laboratories, such as Fontenay for Electricite de France, at Staythorpe for the Central Electricity Generating Board in England, and at K.E.M.A. in Arnheim, Hol-

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MA FACT ERS
PMENT CON TORS

Joint AEIC-EEI Manufacturers Extra-High-Voltage Cable Project Steering Committee. Kneeling *(left to right)* G. P. Adams, Niagara Mohawk Power Corp.; E. D. Eich, Anaconda Wire & Cable Co.; G. E. Rohr, American Elec. Pwr. Service Corp.; and J. J. Rueckert, Baltimore Gas & Elec. Co.; *(second row, left to right)* C. S. Schifreen, Phila. Elec. Co.; H. Halperin, Commonwealth, Edison Co.; R. J. Wiseman, The Okonite Co.; M. H. McGrath, General Cable Corp.; E. J. Merrell, Phelps Dodge Copper Prod. Corp.; and J. H. Nicholas, G. & W. Electric Specialty Co.; *(last row, left to right)* T. F. Brandt, Ohio Brass Co.; L. F. Hickernell, Anaconda Wire & Cable Co.; A. S. Brooks, Public Serv. Elec. & Gas Co.; J. F. Rosson, Cornell University; L. I. Komives, Detroit Edison Co.; and C. T. Hatcher, Con. Edison Co. of N. Y., Inc.

land, cables have been tested under field conditions. However, these have limitations either in test voltage or test temperatures so that the information gathered has been a bit limited in scope. The test program proposed for Cornell indicated that a very thorough study of the effects of voltage and temperature would be undertaken, and in such a way that we could expect to find indications of change in certain characteristics as the severity of testing took effect. It was a challenge that the manufacturers had to meet, knowing the benefits that would result.

Given the problem, we reviewed our standard types of cable which cover operating voltages up to and including 230 kv. Here was an increase of 50% in voltage. What kind of cable should be offered? We had already successfully furnished high pressure oil-filled cable, that is, Oilostatic-type cable for operation at 230 kv. A study of this type of cable indicated that it would not be practical to follow the standard design. Therefore, should we (a) modify the design to meet the conditions set up, or (b) offer an entirely new type of cable, such as a high pressure gas-filled cable or a self-contained type of cable. We decided to modify the standard design. We also carefully reviewed every phase of our manufacturing procedure in order to obtain the best quality of cable possible.

The cable which we have installed has a 2,000-MCM segmental copper conductor, each strand lead alloy coated to reduce interaction between the oil in the cable and the copper, an alloy-coated shielding tape to obtain a smooth circular conductor, a 1.035-inch wall of paper insulation, an alloy-coated shielding tape over the insulation, several polyester insulating tapes, and finally an alloy-coated "D" shaped bronze armor wire over-all. Two of these cables are drawn into a 10¾-inch OD steel pipe. The pipe is filled with oil and is maintained under a 200-psi nominal pressure. As the test circuit is of single-phase design, there is an end loop of a single cable installed in a 5-inch copper pipe. This end loop is connected to the cables in the pipe by two normal-type joints. The ends of the cables are terminated in potheads furnished by the Ohio Brass Company and the G and W Electric Specialty Company.

We are looking forward with great expectations that this investigation will prove to the utilities that the cable manufacturers will be ready to furnish to them 345-kv cable when required. We appreciate the opportunity of taking part in it.

R. J. Wiseman, Vice-President and
Chief Engineer.

PHELPS DODGE

The contribution of the Phelps Dodge Copper Products Corporation, Habirshaw Division, to this joint AEIC-EEI-Manufacturers Extra-High-Voltage Project at Cornell University, consists of a self-contained oil-filled cable system, which embodies thin paper and high oil pressure techniques (200 psig), 1-mil paper being used at the conductor, graduating to 6 mil in the wall, then down to 2 mil at the over-all insulation shield.

Noteworthy features developed by Phelps Dodge are: (1) annealed segmental conductor, (2) use of paper made with deionized water, (3) selected impregnant, (4) large-diameter extruded aluminum sheath, (5) extruded high-density polyethylene corrosion-protective jacket, (6) mechanical joints, (7) combined oil-treating and pumping plant.

The over-all diameter of the cable is 4.68 inches, and, while installed in duct for this test program, the 120-mil high-density high-molecular-weight polyethylene jacket is suitable for direct burial.

Incidentally, consideration should be given to the loading potential of a circuit, consisting of widely spaced single-phase conductors, both from the beneficial effect thermally on the dissipation of losses, and also for the effect on system stability by means of the inductance factor achieved in the wider spacing.

Two 1,000-foot lengths were manufactured for the program, one insulated entirely with paper made with deionized water, the other made with a combination of this paper and our conventional paper. A sample length of each is in the test setup.

Conductor is bare copper, 2,000 MCM, 6-segment compact segmental, annealed, laid over a 0.69-inch ID steel helical core.

Insulation is 1 inch of wood pulp paper, including strand and insulation shielding.

Impregnant is a specially selected water-white petroleum oil, characterized by excellent stability in load cycle testing, and having a freeze point of minus 40C, thereby permitting dry-ice freezing techniques during installation, change-overs, and repairs.

The 220-mil extruded aluminum sheath was applied by swaging.

A feature of the system is that the pumping plant is designed for double duty; that is, it is equipped with a spray nozzle in the storage tank and a vacuum pump, so that oil may be treated, then expressed along the cable oil channel to the location of use. Incidentally, the pumping plant, installed here at Cornell, was employed at the factory to treat the cable impregnant.

Conductor splices were made with conventional compression connectors, employing the G & W 4-ram press. Crepe paper was used for the splice insulation, and the splices are of fully shielded design. Closure was made with a double O-ring sealed mechanical joint assembly.

Both potheads are of condenser stack design, one G & W, the other Ohio Brass, and each is joined to the cable sheath with an O-ring sealed mechanical joint assembly.

The Phelps Dodge installation was begun during February and completed in March. Snow fell 80% of the working days and the temperature hovered near zero much of the time.

In closing, we would like to voice our pride in being associated with this free-enterprise project. Let us all appreciate its significance, not only as a research and engineering operation, but, perhaps more importantly, for its effect in world affairs and the cause of free men everywhere.

E. J. MERRELL, Chief Engineer

ANACONDA

Cable. The Anaconda cable has the following general construction: conductor—1,700 MCM profiled copper conductor, 0.69-inch hollow core without supporting channel; strand shielding—carbon black paper; insulation—1,000-mils graded paper; insulation shielding—carbon black paper; sheath—170-mils F-3 arsenical lead alloy; sheath reinforcement—stainless steel tape, one layer longitudinal reinforcement, one layer transverse reinforcement; covering—150-mils high molecular weight black polyethylene.

The cable is suitable for operation, self-contained at high pressure or at low pressure, and will be operating at Cornell at low pressure (15 psig). The polyethylene covering provides not only corrosion protection but also yields a 3-terminal network amenable of power factor measurement.

Terminals. One terminal manufactured by the Ohio Brass Company is of capacitor graded design housed in a porcelain suitable for operation at high pressure. The other terminal manufactured by Pirelli, S.p.A., is of straightforward stress cone design housed in a porcelain suitable for operation only at low pressure.

Joints. Two joints are installed at one manhole. One joint is a normal (straight-through) joint which connects the cables electrically and hydraulically. The other joint is a stop-joint which connects the cables electrically but isolates them hydraulically. The stop-joint is installed to demonstrate the feasibility of such a design should it be required by the hydraulic characteristics of a commercial installation. At Cornell, the stop-joint will be by-passed hydraulically to simplify the oil supply requirements. Both joints were manufactured by Pirelli.

Oil Supply. Oil for the entire system is supplied from 20-gallon gravity-type reservoirs manifolded and installed atop a 35-foot wooden structure. The reservoirs were manufactured by Jerome Hydraulics, Inc.

Research Objective. Principal objectives to be investigated are:

1. Whether low-pressure potheads are suitable for this voltage and whether there is significant difference in performance between stress-cone-graded and capacitor-graded designs.

2. Whether cable with reinforced lead sheath operates satisfactorily at high power capabilities in duct lay installation.

3. Whether low-pressure self-contained cable type is suitable for 500,000-kva minimum at 345 kv.

4. The lowest practical obtainable power factor with cellulose insulation maintainable at high temperature and voltage over extended periods.

E. D. EICH, Assistant Chief Engineer,
HIGH VOLTAGE CABLES

CONTRIBUTORS OF EQUIPMENT AND SERVICES TO THE EHV CABLE FIELD TEST PROJECT AT CORNELL SPONSORED BY AEIC AND EEI

Suppliers of Test Samples

Anaconda Wire & Cable Company
G & W Electric Specialty Company
General Cable Corporation
The Ohio Brass Company
The Okonite Company
Phelps Dodge Copper Products Corp.

Service Utility

New York State Electric & Gas Corporation

Equipment and Services

Brewer-Titchener Company
Burndy Corporation
W. A. Chester, Inc.
Electric Storage Battery Company
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General Electric Company
R. G. Goodyear & Son
Hi-Voltage Equipment Co.
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Long-Time Heat Runs on Underground Cable

T. A. BALASKA
MEMBER AIEE

A. L. McKEAN
MEMBER AIEE

E. J. MERRELL
FELLOW AIEE

HEAT-RUN DATA have been obtained on an underground cable test installation, located in the side of a thoroughly drained sand hill sloping to the west and protected from local replenishment of soil moisture by the black-top cover of a company parking area. Selection of this location for an underground test site was based upon the existence of topography and soil characteristics typical of a marginal field condition from a soil-thermal point of view.

Particular interpretations of the data obtained during the past 3 years, being too comprehensive for a single presentation, will be the subject of future reports. On the other hand, it has been deemed worthwhile to make the actual data available for general reference.

The test arrangement is designed to provide thermal characteristics for different types of buried conduit systems, including the effects of mutual heating in multiple installations. Such a condition is likely to be, and has been, encountered in city streets. It consists of three parallel runs installed on 3-foot centers between manholes on a 4% grade, lengths being 80 feet, manhole to manhole. Construction details include the following: 8⅝- and 4½-inch steel pipes, somastic coated, at 3.5 feet of cover depth; 4-inch transite duct, 2 by 3 inches laid in concrete with a 2.5-foot cover depth.

A controllable thermal grid is installed over the runs, at a depth of 1 foot, as a means for introducing supplementary heating.

Two thermocouple stations, each containing 30 positions, are set up to monitor the thermal pattern at test cross sections located 25 feet away from each manhole. Test points have been set in the vertical plane at the pipe surface, as well as 6, 18, 30, and 42 inches above it; the thermocouples, located 42 inches above the pipes, are embedded in the center of a 3-inch layer of black top. Test points also are included to provide the horizontal pattern at conduit depth.

In the case of the duct bank, the thermocouples in the vertical plane include the duct bank surface and 6, 18, and 30 inches above it, the 30-inch junction likewise being embedded in black top. Thermocouples are also located within the ducts at each test cross section.

Ground ambient reference thermocouples are located outside the thermal zone, at least 10 feet to either side of the center line of the test area. Five thermocouples are included. An additional feature of the test setup comprises a soil-wetting system.

The test site excavation between manholes was a trench 5 feet deep, 12 feet wide, and 80 feet long. The native soil consists of a gravel and sand mixture containing relatively small amounts of silt and clay. During the course of backfilling, a building sand of a formulation different from that of the native soil was employed as a bedding and a 6-inch cover layer for the pipes.

Samples of both backfill sands were sent to Princeton University for analysis in connection with the AIEE Soil Thermal Resistivity Research Project. The backfill procedure was based on construction practices generally followed at this period. Vibration and mechanical tamping of the bedding and cover layer, employing building sand, was followed by completion of backfilling with native soil. Mechanical tamping of each 1-foot layer of native soil provided further compaction. Moderate rainfall during this phase of work contributed to compacting. Final densification was accomplished by a 1-ton power roller. The method of compaction appears to have been quite effective in that no settlement has occurred despite the daily traffic over the test setups. Pavement restoration consisted of a crushed stone base, covered with a 3-inch layer of bituminous black top.

Cable loading is simulated by nichrome heater wires, installed in each pipe and in the two top tiers (four ducts) of the duct bank. Insulating spacer plates are utilized to support the heater wires concentrically so as to provide a more uniform heating. Ducts and pipes are sealed in both manholes to prevent ventilation.

The initial test program, completed during the past 3 years, consisted essentially of obtaining thermal characteristics under no-load (ambient) and under 100% load factor conditions.

During the course of this program a series of thermal (transient) needle measurements were made in an effort to correlate rho determinations by this method against that obtained by buried thermocouple measurements. This work will be the subject of a separate report, when completed.

Soil resistivity was about 60 initially. However, significant changes occurred in the course of the test runs. Thus, rhos of 285 in the 6-inch zone, 200 in the 18-inch zone, and 150 over-all were obtained on the 8-inch pipe at the end of the loading period.

While the soil rho deteriorated under the loading imposed, the over-all characteristic was essentially one of gradual change, approaching a horizontal asymptote over a period of months.

Digest of paper 60-809, recommended by the AIEE Insulated Conductors Committee and approved by the AIEE Technical Operations Department for presentation at the AIEE Summer General Meeting, Atlantic City, N. J., June 19-24, 1960. Published in AIEE *Power Apparatus and Systems*, Oct. 1960, pp. 757-71.

T. A. Balaska, A. L. McKean, and E. J. Merrell are with Phelps Dodge Copper Products Corporation, Yonkers, N. Y.

Wire-Line and Carrier Communications on the Union Pacific Railroad

C. O. JETT

MEMBER AIEE

The history and development of the wire-communications plant of this railroad, including teleprinter, telephone, data, and specialized facilities, are presented.

COMMUNICATIONS in the area presently served by the Union Pacific Railroad Company preceded the railroad by several years. The telegraph line of the Overland Telegraph Company, starting at Omaha, Nebr., and extending westward through Salt Lake City, Utah, to San Francisco, Calif., was constructed in the years 1860 and 1861; while the construction of the railroad did not start until 1864.

The original telegraph line was hastily constructed, and later, when it became necessary to rebuild, the line was moved onto the right-of-way of the Union Pacific Railroad, thus becoming the first wire communication facilities of the railroad company. Over the years, more and more wire was added to the line for train dispatching, operation, and administrative purposes. Prior to 1912, only Morse telegraphy was used; however, in 1912, the first telephones were installed on the Union Pacific. The wire-line plant reached its peak in miles of pole line and wire mileage in the early 1920's.

In the late 1920's, voice repeaters were installed on a number of circuits to permit direct telephone communication from headquarters at Omaha to points as far west as Salt Lake City, Utah. Various types of printing telegraph machines were installed on the Union Pacific Railroad as early as 1918, and 4-channel Morkrum multiplex teleprinters were used as late as 1946, at which time all the teleprinter facilities were replaced with modern teleprinter equipment.

With the advent of carrier techniques and improved business conditions in the fall of 1937, a Western Electric type *CN-4*, 3-channel carrier system was furnished and installed by the Western Electric Company between Salt Lake City and Los Angeles, Calif. From this time on, the growth of business and the requirements for more and better communications necessitated rapid expansion of all forms of communications on the Union Pacific Railroad. Many single-wire Morse telegraph circuits were paired for telephone operation, voice transposed, and additional telephone instruments installed. Between a number of the more important offices, teleprinter facilities were expanded.

In 1941, just prior to the start of World War II, a Western Electric type *C-5*, 3-channel carrier system was installed between Omaha and Salt Lake City with terminals back-to-back at Cheyenne, Wyo., to provide much-needed additional facilities. In rapid succession, a 3-channel carrier system (Western Electric *C-5*) was installed between Salt Lake City and Portland, Ore., and a second 3-channel system (Western Electric *C-5*) was installed between Omaha and Salt Lake City, to provide direct circuits from Omaha to Los Angeles, Salt Lake City, and Portland.

Restrictions on electronic equipment precluded any expansion of communications during World War II, except those that were mandatory for the handling of military operations. However, with cessation of hostilities, it became readily apparent that a major expansion must be made to provide administrative teleprinter facilities to consolidate the far-reaching points of the Union Pacific Railroad. The new facilities for teleprinter service were provided by voice-frequency carrier telegraph techniques. At the same time, many additional single-channel short-haul telephone carrier channels were provided on the railroad by installing second- and third-story carrier systems over Western Electric's type *H-1* carrier systems which had been installed during the period 1939-45.

TELEPRINTER FACILITIES

AS MENTIONED PREVIOUSLY, the Union Pacific Railroad first entered the field of voice-frequency carrier telegraph facilities in 1946. In 1948, it was realized that many more channels for teleprinter service would be required than were available utilizing the conventional 170-cycle spacing for voice-frequency carrier telegraph service. It was, therefore, decided to utilize equipment with 120-cycle spacing which would permit one-third more channels to be installed on a voice band. Furthermore, a number of channels had been tried out in 1946 on what is now called "speech-plus-duplex." This technique involves removing that portion of the voice band between 1,450 and 1,900 cycles by suitable filters and installing two carrier telegraph channels within that space. The 120-cycle spaced channels then permit four carrier-telegraph channels to be installed in the same space previously used by two 170-cycle carrier channels, thus doubling our teleprinter

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Essentially full text of paper 60-815, recommended by the AIEE Wire Communication Systems Committee and approved by the AIEE Technical Operations Department for presentation at the AIEE Summer General Meeting, Atlantic City, N. J., June 19-24, 1960. Published in AIEE *Communication and Electronics*, 1960.

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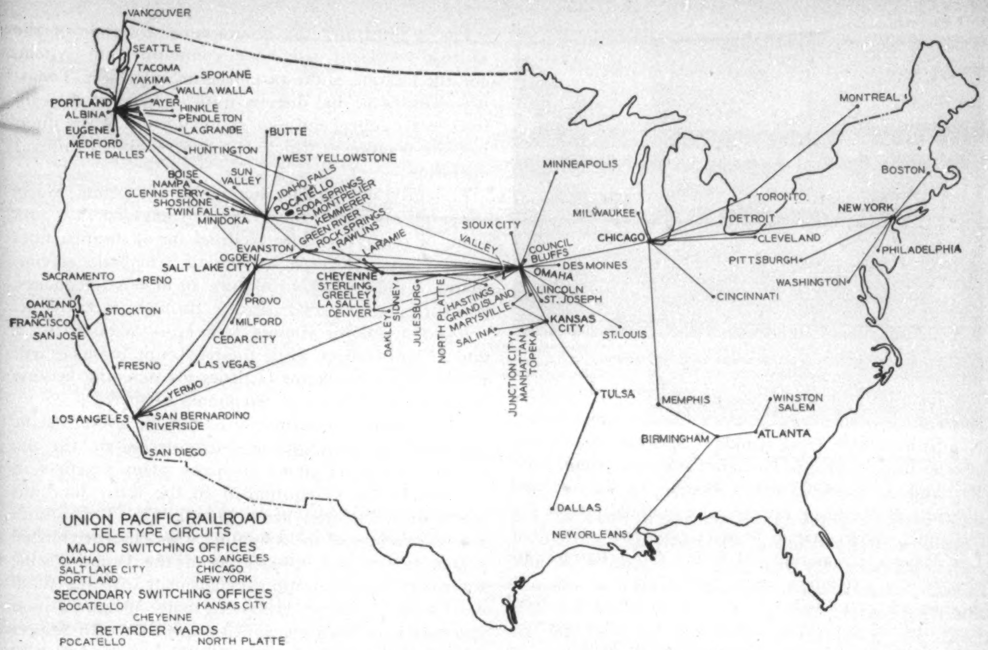
VANCOUVER
SEATTLE
TACOMA
YAKIMA
SPOKANE
WALLA WALLA
PORTLAND
ALBINA
AYER
HINKLE
PENDLETON
LA GRANDE
EUGENE
MEDFORD
THE DALLES
HUNTINGTON
BUTTE
WEST YELLOWSTONE
BOISE
NAMPA
GLENNS FERRY
SHOSHONE
TWIN FALLS
MINIDOKA
SUN VALLEY
IDAHO FALLS
POCATELLO
SODA SPRINGS
MONTPELIER
KEMMERER
GREEN RIVER
ROCK SPRINGS
RAWLINS
LARAMIE
EVANSTON
OGDEN
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SACRAMENTO
RENO
OAKLAND
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CHEYENNE
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TOPEKA
SIOUX CITY
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PHILADELPHIA
UNION PACIFIC RAILROAD
TELETYPE CIRCUITS
MAJOR SWITCHING OFFICES
OMAHA
SALT LAKE CITY
PORTLAND
LOS ANGELES
CHICAGO
NEW YORK
SECONDARY SWITCHING OFFICES
POCATELLO
KANSAS CITY
CHEYENNE
RETARDER YARDS
POCATELLO
NORTH PLATTE

Fig. 1. Union Pacific Railroad's teletype circuits.

channel facilities. Today, a major portion of the railroad's teleprinter facilities are derived by the "speech-plus-duplex" technique. There is only one location (Omaha-Salt Lake City) in which an entire voice band is utilized for voice-frequency carrier telegraph service.

Several years ago, to provide additional facilities for teleprinter service, it was found that the only space available for expansion was in that band of frequencies lying above the voice range and below the "C" carrier systems and which has a frequency range of approximately 2,900 to 5,100 cycles. Twelve specially designed voice-frequency carrier telegraph channels were then inserted into that space and today the railroad operates 72 channels at various points in this band.

The present extent of the teleprinter service on the Union Pacific Railroad is shown by Fig. 1. It may be noted that the number of channels between various locations is not given; however, this factor is rather indefinite as channels are set up on patch basis from time to time depending upon service requirements. For locations not physically on the Union Pacific Railroad, circuits are obtained by lease from common-carrier communication companies. There are a number of relay points to relay messages from one location to another. The torn-tape method is utilized to provide direct relaying without repunching a message. A typical teleprinter torn-tape relay center with six ganged transmitter-distributors on the left and each cabinet on the right containing three typing reperforators is illustrated by Fig. 2. Primary relay points are located at Omaha, Salt Lake City, Los Angeles, Portland, Chicago, and New York City. Secondary relay points are located at North Platte, Kansas City, Cheyenne, Pocatello, and Hinkle.

Typical teleprinter sending facilities are illustrated in Fig. 3.

TELEPHONE FACILITIES

In 1955, after a careful review of the railroad's existing communication facilities, it was determined that a definite requirement existed for more and better communications at many points on the railroad. Further, it was deemed advisable to provide direct-distance-dial facilities throughout the entire railroad system. Since the existing outside wire plant was fully loaded in most instances, in that it would be impossible to add additional wire without major rebuild of the pole line, it was only possible to provide this additional service by means of carrier techniques. Therefore, a major expansion into carrier facilities was started.

During the years 1955 to 1958, "C" carrier systems were installed from Omaha to Kansas City; Omaha to North Platte, Nebr.; North Platte to Cheyenne; Cheyenne to Green River, Wyo.; Green River to Ogden, Utah; Ogden to Salt Lake City; Cheyenne to Denver, Colo.; Kansas City to Salina, Kans.; Salina to Denver;

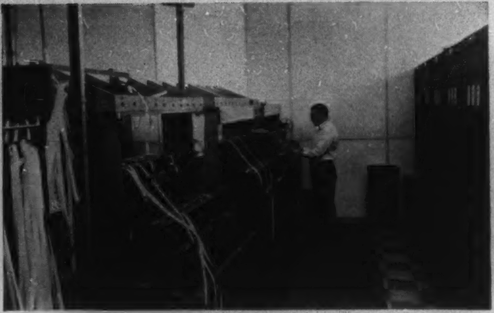

Fig. 2. Teleprinter torn-tape relay equipment.

Salt Lake City to Pocatello; Pocatello to Nampa Idaho; Nampa to Hinkle, Ore.; Hinkle to Spokane, Wash.; two systems from Hinkle to Portland; and two systems from Portland to Seattle. Further, because of the age and difficulty of obtaining maintenance material for the *C-4* 3-channel carrier system between Salt Lake City and Los Angeles, it was replaced with a *C-5* 3-channel carrier system extending from Salt Lake City to Los Angeles with terminals back-to-back at Las Vegas, Nev. Even this was not enough. Therefore, it was necessary to enter the high-frequency telephone-carrier field.

A Western Electric "OB" system was installed from Omaha to Cheyenne and from Cheyenne to Salt Lake City. An "OC" carrier system was installed from Omaha to Cheyenne. An "OB" carrier system was installed from Salt Lake City to Pocatello, Pocatello to Nampa, and Nampa to Hinkle. Also, from Salt Lake City to Las Vegas, and Las Vegas to Los Angeles. Still not enough voice-frequency channels were available for the requirements. The "OB" and "OC" carrier systems were then replaced with Lenkurt type *45-A* 12-channel open-wire carrier installations. Prior to the installation of the 12-channel carrier systems, it was necessary to retranspose for 150-kc operation several pairs of wires from Omaha to Salt Lake City, Portland, and Los Angeles. Upon completion of the transposing, 12-channel carrier systems were installed as follows: One direct system between Omaha and Salt Lake City with 16 repeaters. On the adjacent pair a second 12-channel system was installed with terminals back-to-back at Grand Island, Nebr., North Platte, Cheyenne, and Green River. Also, 12-channel systems were installed between Salt Lake City and Las Vegas, and Las Vegas and Los Angeles, and another system was installed from Salt Lake City to Portland with terminals back-to-back at Pocatello and Nampa. The "O" carrier systems that had been removed were reinstalled to provide additional facilities between Omaha and Kansas City, and an "OB" and "OC" system from Cheyenne to Denver. Type "OB" carrier systems were also installed from Kansas City to Salina, Cheyenne to Laramie, Wyo., Ogden to Salt Lake City, and from Los Angeles to San Pedro, Calif.

Fig. 4 illustrates the geographical coverage of the railroad's present telephone communication system, and the location of the various switching offices. Today, it is possible to dial directly from one end of the railroad to the other, and to a major portion of the intermediate telephones which are so necessary to railroad operation.

Presently, due to the shortage of competent Morse telegraph operators, the railroad is engaged in a program of converting wire facilities on all branch lines from Morse telegraph service to telephone service. Many of these branches require 10 or less telephones, permitting direct dial service through recently developed decimonic ringing techniques adapted for *E* and *M* lead control, while the remaining branches will utilize $3\frac{1}{2}$-cycle selector facilities for signaling because of the larger number of telephones involved.

The complexity and magnitude of the Union Pacific Railroad's communication system necessitate the use of commercial telephone company plant practices in the installation of equipment in the many locations where such facilities are required. Fig. 5 illustrates typical practices of the communication office at Omaha.

Due to the long association of the Union Pacific Railroad's communications department with the Western Union Telegraph Company, many Western Union practices have been continued, especially with respect to testing and patching the open-wire plant. A typical railroad testing and patching switchboard installation is shown in Fig. 6.

DATA FACILITIES

In 1956, the railroad entered into a program to expedite movement of trains and the handling of identifying correspondence by employing techniques called electronic data-processing methods, or, in simple language, "machine accounting." Equipment manufactured by the International Business Machines Corporation (IBM) was utilized. Originally, the data was trans-

Fig. 3. Typical teleprinter sending facilities.

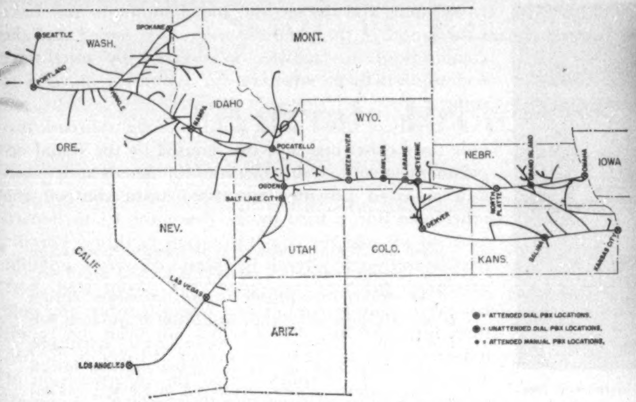

Fig. 4. Union Pacific Railroad's telephone channel facilities.

Fig. 5. Typical communication equipment rack.

mitted on teleprinter channels and converted from card to tape and tape to card on a local basis, but this procedure was cumbersome, wasteful of manpower and much too slow.

The program of data transmission was speeded up in 1957 by the elimination of the intermediate process of card to tape and tape to card by utilizing the transceiver manufactured by IBM, which transmitted a card from one transceiver to a similar transceiver at the distant end on 100-wpm teleprinter channels. After approximately a year's experience with this type of equipment, it was realized that it, too, was inadequate for the assigned task, and that it would be necessary to use higher speeds which necessitate using the voice-frequency-type transceiver, on a 4-wire basis, whereby four transceiver channels can be derived from one voice-frequency telephone channel, resulting in the doubling of the number of cards per minute transmitted and received by each transceiver circuit.

Early in 1958, a comprehensive data system was established over the entire railroad to feed data from the various originating points to the IBM model *705* computer located at Omaha, for car record operation between the various reporting offices. This system is illustrated in Fig. 7.

Today, two types of data are being handled on the present facilities. One type is the "car record" which is the operational record of all freight cars moving throughout the Union Pacific system, and to connecting railroads. The second type of data transmitted is "payroll accounting" in which the payroll records of the employes of the railroad are channeled daily to the computer in Omaha, where the payroll record is kept and the checks prepared for payment on a semimonthly basis.

SPECIALIZED FACILITIES

Only in railroad operation is it necessary for one person to direct and control an entire facility covering, in many instances, several hundred acres. This is the condition that exists in railroad yards. To expedite the movement of trains and the switching of cars through the various terminals, it has been necessary to establish large intercommunicating and paging facilities whereby the supervisor can contact and direct many different persons, diesel switching crews and repair forces. This is accomplished by means of strategically located paging speakers and 2-way talkback speakers which permit an employe to signal his supervisor, or the supervisor to speak to personnel even when they are several hundred feet distant from the speaker. Each of these yard intercommunicating systems is custom engineered to provide the best coverage in view of the service requirements. This service in the yards is generally provided through buried multiconductor telephone cables comparable in many cases to the telephone exchange plant in villages and small towns. Yards frequently have 15 to 25 paging speakers and as many as 100 2-way talkback speakers, all under control of one supervisor. A similar problem exists in the modern terminal freight house with incoming and outbound freight and trans-shipment of freight from one car to another, in that the entire operation must be under the direct control of one individual. The problem most generally is solved with a system somewhat smaller to that utilized for yard operations.

FUTURE

Presently, there is no further room for expansion on the wire-line communications plant and yet the requirements exist for more facilities for voice communications, teleprinter channels, and for the transmission of data of many types and from many places on the Union Pacific into Omaha. The cost to expand the wire communications plant would be prohibitive. The railroad, therefore, is entering into a program of installing a microwave radio communication system. Presently under construction is a system from Omaha

Fig. 6. Typical wire-testing and patching facility on a railroad communication system.

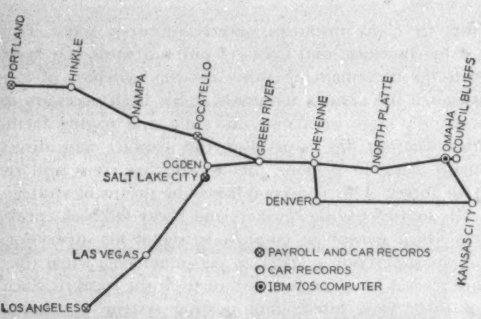

Fig. 7. Union Pacific Railroad's data-transmission system.

to Laramie, and the section from Laramie to Salt Lake City is now in the planning stage. It is hoped that the communications facilities so derived by microwave techniques will be adequate for a number of years to come.

Presently over the major portion of the railroad, two pole lines exist: one pole line is used by the signal department to control the operation of signals and in certain areas to provide centralized train control; the other pole line is used by the communications department to provide the communication facilities. For the past several years, when it has been necessary to rebuild or replace either of these pole lines, a concerted effort has been made to consolidate, where feasible, the pole lines into one line. Progress has not been too rapid, frequently due to the large number of wires of the two departments. It is believed that the incorporation of microwave radio facilities into the railroad's communication plant wil permit the elimination of considerable pole line mileage by reducing the number of wires needed by the communications department, which will then permit one pole line to serve both departments.

It is possible that a certain number of carrier systems will be retired because the service they are performing can be more easily performed by microwave techniques, but due to the scarcity of population in the area served by the Union Pacific Railroad, there is limited availability of commercial telephone facilities along the railroad's right-of-way. It is mandatory that the railroad be able to get in touch with many of its employes living at isolated areas along the right-of-way in the event of emergencies and other conditions requiring their services on an unscheduled basis, and it is only through railroad communication facilities that this personnel can be contacted.

Major Relay-Design Advance

A printed-contact permanent-magnet relay, which makes possible substantial savings in space, weight, and assembly costs, has been developed by the Components Division of Executone, Inc. The new relay, known as Printact (registered trademark) represents a new approach to relay design and manufacture.

The new relay is mounted on and becomes an integral part of a printed-circuit board. Fixed contacts are eliminated entirely and the moving contacts which are part of the armature assembly are designed to mate with conductors on the printed board. The new device employs a permanent magnet in place of a spring to hold the relay armature open. This force remains constant and eliminates any adjustment or maintenance.

Development of the new relay came about as the result of problems with conventional relays encountered by Executone, Inc.

Photo shows individual memory module that registers up to 40 items of information in a doctor's register and has 20 Printact relays occupying 8¼ by 5¾ by 1 inches of space.

Static vs. Relay Logic for Aircraft Protective Panels

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Reasoned argument is made against the indiscriminate use of transistor or other "static" elements replacing electromechanical relays without making a thorough reliability analysis. In a particular application, an aircraft protective panel design using relays as logic elements is herein shown to be more reliable than a particular equipment transistorized design.

WITH the advent of transistors and other semiconductors, there has been considerable effort expended toward using these "static" elements for replacement of electromechanical devices such as relays. The basic force behind this effort has been, of course, the intuitive feeling that such static devices are inherently more reliable than components having moving elements that can wear and stick or consumable elements that eventually become expended. This feeling has in many cases become fact; however, many an engineer has been lured to transistorized designs which have turned out to be complicated nightmares with poorer performance and less reliability than those using conventional techniques. This is especially true where the equipment must operate within wide temperature and supply voltage variations.

As in all good design, the advantages and disadvantages of each design technique as applied to the specific application must be considered. The very special characteristics of transistors, such as their small size and power dissipation, fast speed of response, and high shock and vibration resistance, all but eliminate the relay from consideration for some applications. Conversely, there are those functions that are uniquely fulfilled by electromechanical devices such as contactors for high-power switching, etc.

One area where transistors have found wide application and in many instances have displaced relays is in the logic functions of computers and similar applications. In comparing characteristics, the advantages of a given technique are often quite obvious, such as speed of response, or the need for billions of operating cycles. The consideration of reliability in these comparisons has usually been used as a blind justification to favor transistors over relays, whereas the relay actually may be the more reliable.

One such application where a careful analysis shows that the relay approach is the more reliable is in the logic and switching functions of a typical control and protective panel of an aircraft electric power system. (Such a panel which provides supervisory control and performance protection is in effect a small computer.) The reasons for this conclusion are presented and discussed herein. They are based upon a logical prediction of reliability using component failure-rate data obtained from actual field experience. The reliability prediction process assumes that circuitry is essentially a series arrangement; i.e., failure of any one component will cause failure of the whole panel. It further assumes that the components exhibit constant failure rate. A direct comparison between circuits can be made therefore, by merely totaling the failure rates of the component parts.[1]

LIFE CHARACTERISTICS COMPARED

BEFORE SUCH A COMPARISON is made, it is advantageous to consider the life characteristics and modes of failure of the various components so that a more accurate estimate of failure rate can be made. Relays along with vacuum tubes, switches, etc. have had a rather poor reputation for reliability. Using a generalized past history, a designer could justifiably eliminate the use of relays from consideration. However, some relays have performed admirably and great design improvements recently have been made, thereby changing the picture considerably.

Failure of relays may result from coil failures, misoperation of contacts, or from other causes. Coil reliability is obtained by using proper insulating materials for the environment and conservative design techniques to limit small wire sizes, and detrimental temperature rises. Contact reliability results from proper attention to a number of factors. Dry circuits; i.e., those having very low contact current, are avoided since this is a cause of many failures to "make" contact. High currents for a given size contact are avoided as they cause welding or sticking of contacts. Dirt within the hermetically enclosed relay can cause random sticking of the mechanism or failure to "make" if it gets between contacts. These faults can be virtually eliminated by use of special or "white room" manufacturing facilities and a run-in of 10 to 15,000 operations. There is, of course, no substitute for a dependable mechanism. Life tests have shown that failure due to wearout can be extended to 1 to 5 million operations which far exceeds

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Essentially full text of paper CP60-1045 recommended by the AIEE Aero Space Transportation Committee for presentation at the AIEE Pacific General Meeting, San Diego, Calif., Aug. 8-12, 1960.

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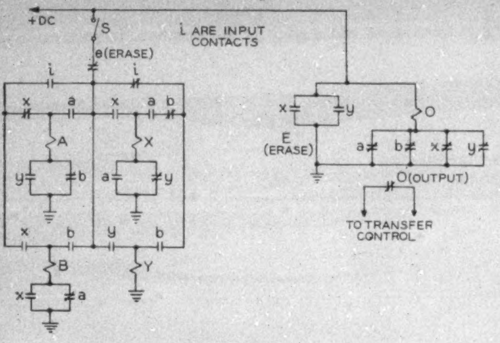

Fig. 1. Relay 4-trip counter with erase feature.

the 50,000 maximum number of operations required for an aircraft panel. As a result of attention to these factors, a properly manufactured, tested, and applied relay can have a failure rate of less than 1% per 1,000 hours in a typical aircraft panel environment.

Transistors not only fail catastrophically but can cause faulty circuit operation because of changes in characteristics. When presently available transistors are run at constant low temperatures, very favorable failure rates (as low as 0.01% per 1,000 hours) can be obtained. However, in the —65 to 120 C ambients encountered in aircraft, a practical value of 0.7% per 1,000 hours can be attained only with careful application. Resistors of the type that would be used in transistorized logic circuits have a failure rate of approximately 0.1% per 1,000 hours.

As mentioned previously, the failure rates established for this analysis are based upon field experience and published data.[2] The actual value is influenced by the particular environment, and upon the type of component used to accomplish the design objectives of the equipment in question. For example, in an aircraft protective panel where minimum size and weight are design objectives, the designer is compelled to operate his components at or near rated values. This is the situation under which the failure rates were established for this analysis. It is recognized that the literature[2] shows sharp declines in failure rates as the stress level and the ambient temperature are reduced; however, this can only be accomplished at the expense of added weight and cost. For instance, one group of investigators has used a failure rate of 0.5% per 1,000 hours for relays and 0.5% per 1,000 hours for transistors based on information from Wright Air Development Center; however, we feel that 1% per 1,000 hours and 0.7% per 1,000 hours, respectively, are more nearly correct for the equipment being analyzed.[1-3] These latter values are heavily weighted by our own experience with an aircraft electric system used in the Electra turbo-prop commercial airliner wherein failure data has been accumulated for a total of 369,000 panel-hours of actual flight. No amount of laboratory simulation can be substituted for this type of information. It is of interest to note that the prediction of equipment failure rate made prior to receipt of any field data and based on information then available in the literature was within 6% of that actually experienced. These failure rates are, as mentioned, assumed to be constant and do not include the usually high early failure or infant mortality losses or wearout failures. Since relay contact life is more a function of the number of operations rather than time, the infant mortality period can be easily and inexpensively eliminated by a run-in of 10 to 15,000 operations. By contrast, semiconductors which have a very high infant mortality failure rate compared to their constant failure-rate value require very expensive and long run-in tests. One manufacturer of a transistorized aircraft control panel found an initial panel failure rate of 1,250% per 1,000 hours (an 80-hour mean time between failures), and after extensive component and panel run-in testing reduced it to an acceptable 25% per 1,000 hours. Only very short run-in tests for the Electra control panel (which uses relay logic and switching) have been found necessary.

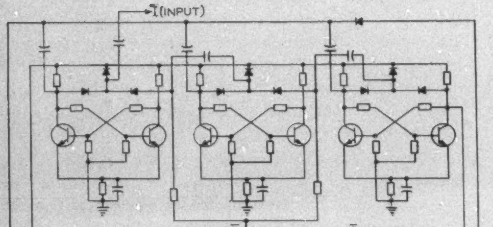

Fig. 2. Transistorized 4-trip counter with erase feature.

TRANSISTORIZED PANEL MORE COMPLEX

When comparing circuits it is striking to note the much greater complexity of a transistorized panel over one using relays. The major reason for this is that one cannot merely replace a relay with a single transistor. The exact number of additional components required depends on the circuit approach, but various sources show that approximately one transistor, four resistors, and an occasional diode and capacitor are necessary to replace one relay contact. A single 4-pole double-throw relay requires, therefore, at least 4 transistors and 16 resistors. Other factors which increase complexity are the transistor's need for a closely regulated power source, protection against transients, and temperature compensation.

To illustrate this, an analysis is made of a particular logic circuit called a "4-trip counter with erase feature."

Its purpose is to transfer load from the main electric system to an emergency system when a fault occurs and does not clear itself after being cyclically reset. The main system is "sensed" four times for the fault, and is shut down and transferred permanently if a fourth closely spaced trip signal occurs. If the fault is cleared before the fourth trip, the electric system is returned to its normal condition and remains there. The erase feature "erases" the previous information and resets the "information storage" portion of the circuit, thereby returning the counter to its original state.

A method of applying relays to accomplish these functions is shown in Fig. 1. The transistorized version is shown in Fig. 2. A brief analysis of Fig. 1 shows that the circuit operates as follows: The pilot closes switch *S* when turning on the electric system. The input or signal in Fig. 1 is the closing of the contacts *i* of relay *I* (coil not shown in Fig. 1) when a fault occurs. The number of times a fault is sensed is recorded by the opening of one of the normally closed contacts *a, b, x,* and *y.* When all of these contacts are opened the output of the system consists of the de-energizing of the relay *O.* This closes the transfer control circuit and transfers the electric system to the emergency generator. The erase feature consists of the time delay relay *E* (erase) being actuated after a predetermined time and momentarily opening contacts *e* (erase), thus de-energizing, or erasing all the circuits.

In Fig. 2 the pilot closes the switch *S* and a fault causes an input signal $\overline{I}$ to be impressed upon the first of the "steered" flip-flops. When the last flip-flop is in the conducting state the output of the system consists of an output signal *O*, de-energizing the relay *O* and causing contacts *o* to close. This closes the transfer control circuit and transfers the electric system to the emergency generator. The erase feature consists of the time delay relay *E* (erase) being actuated after a predetermined time and closing contacts *e* (erase). The positive voltage $+V_{pa}$ is then placed on each flip-flop reverting them to the original state experienced before the counting began.

TABULATION OF FAILURE RATES

Tables I and II are the tabulation of the components and their failure rates for the circuits of Figs. 1 and 2. It is to be noted that the relay circuit failure rate of 7% per 1,000 hours is 2.68 times better than the transistorized circuit. It is to be further noted that the increased complexity is such that the relay circuit is better even if the transistors were considered perfect (0% per 1,000 hours failure rate). It is again emphasized that this comparison is for a particular set of components and for a particular requirement; however both approaches are believed to have the same degree of design conservatism, component quality, and quality control. Further derating of components used in the transistorized approach, combined with better quality control etc., could substantially decrease its failure rate; but similar efforts directed at the relay approach will also reduce its failure rate a comparable amount. For instance, using the data in Navships 900-193 with a low ambient temperature and a high degree of derating (including 20% of rated power on transistors and 20% of rated contact current on relays), the failure rates can be estimated to be 2.1% per 1,000 hours and 1.7% per 1,000 hours respectively.[2] (This result still shows the relay approach to be superior.) It should be recognized that such derating of this transistor circuit would be impractical, for it would require use of larger and consequently heavier (perhaps four times) and more costly components, or more of the lower level units which would in turn contribute to greater total failure rate. At the same time, the relays used in this application have characteristics which have already allowed this high degree of derating. As the ambient temperature requirements increase, the advantages of the relay become more apparent as the failure rates of the transistors increase much more rapidly with temperature than do relay failure rates.

Table I. 4-Trip Counter with Erase Feature (Relays)

Component	Total Quantity	Failure Rate*	Total Failure Rate*
Relays	7	1.0	7.0

*The failure rate is in per cent per thousand hours.

As a further illustration, a comparison is made of a complete protective panel designed for use in a high performance military aircraft, and utilizing the trip counters of Figs. 1 and 2. One is completely transistorized, including the various sensing circuits such as over-voltage sensing, etc. The other uses sensing circuits based on magnetic amplifiers combined with relay logic. Tables III and IV, which tabulate the components and failure rates, show the relay panel failure rate to be 1.98 times better than the transistorized panel. The failure rates of the control panel are broken down into the categories of power supply, sensing circuit, and logic circuit in Tables III and IV to assist in analyzing the relative failure rates of the two approaches. Note that the power supply of the transistorized panel has more components and a higher failure rate. As would be expected, the failure rates of the sensing circuits are approximately equal. The relay logic failure rate is 3.6 times as good as the transistorized logic failure rate and

Table II. 4-Trip Counter with Erase Features (Transistors)

Component	Quantity	Failure Rate*	Total Failure Rate*
Transistors	10	0.70	7.00
Diodes and Rectifiers	13	0.45	5.85
Capacitors	9	0.08	0.72
Resistors	32	0.10	3.20
Relays	2	1.00	2.00
	66		18.77

*The failure rate is in per cent per thousand hours.

Table III. Aircraft Control Panel Using Relays

	Power Supply			Sensing Circuits			Logic Circuits		
	Quantity	Failure Rate*	Total Failure Rate*	Quantity	Failure Rate*	Total Failure Rate*	Quantity	Failure Rate*	Total Failure Rate*
Transformers	1	0.5	0.50	3	0.5	1.50	0	0.5	—
Chokes	2	0.18	0.36	4	0.18	0.72	0	0.18	—
Mag. Amps	0	2.00	0.00	2	2.00	4.00	0	2.00	—
Relays	0	1.00	0.00	3	1.00	3.00	14	1.00	14.00
Zeners	1	0.45	0.45	0	0.45	0.00	0	0.45	—
Rectifiers	4	0.45	1.80	26	0.45	11.70	0	0.45	—
Capacitors	1	0.08	0.08	3	0.08	0.24	0	0.08	—
Resistors	2	0.10	0.20	17	0.10	1.70	0	0.10	—
			3.39			22.86			14.00

Power Supply failure rate = 3.39
Sensing Circuits failure rate = 22.86
Logic Circuits failure rate = 14.00
Total Panel failure rate = 40.25

*The failure rate is in per cent per thousand hours.

Table IV. Aircraft Control Panel Using Transistors

	Power Supply			Sensing Circuits			Logic Circuits		
	Quantity	Failure Rate*	Total Failure Rate*	Quantity	Failure Rate*	Total Failure Rate*	Quantity	Failure Rate*	Total Failure Rate*
Transistors	0	0.7	0.00	5	0.7	3.50	31	0.7	21.70
Transformers	1	0.5	0.50	3	0.5	1.50	0	0.5	0.00
Chokes	4	0.18	0.72	8	0.18	1.44	2	0.18	0.36
Relays	0	1.00	0.00	0	1.00	0.00	4	1.00	4.00
Zeners	2	0.45	0.90	4	0.45	1.80	3	0.45	1.35
Rectifiers	6	0.45	2.70	26	0.45	11.70	26	0.45	11.70
Capacitors	3	0.08	0.24	8	0.08	0.64	9	0.08	0.72
Resistors	2	0.10	0.20	36	0.10	3.60	106	0.10	10.60
			5.26			24.18			50.43

Power Supply failure rate = 5.26
Sensing Circuits failure rate = 24.18
Logic Circuits failure rate = 50.43
Total Panel failure rate = 79.87

*The failure rate is in per cent per thousand hours.

results in the total failure rate of the relay panel being approximately twice as good as the transistorized panel.

CONCLUSIONS

1. WHEN INVESTIGATING the reliability of a design it is necessary to consider the particular components used in light of the particular specification requirements.

2. Techniques are now available with which to make realistic reliability predictions of designs and permit comparison of various design approaches.

3. It has been shown that an unreliable approach in one application may be the more reliable in another. A particular aircraft protective panel design using relays for logic was shown to have greater reliability than a particular equivalent transistorized design using presently available components.

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Electrical Conductor Buses

A group of enormous aluminum tubes have been fabricated by the Delta Star Electric Division of H. K. Porter Company, Pittsburgh, Pa., into what are believed to be the world's largest electrical buses, both in physical size and in amperage capacity. For use as "generator leads" or "station bus" (to carry electric energy from a turbine generator into the switchyard of a power plant), the buses are 19 and 20.5 inches in diameter, with $\frac{5}{8}$-inch walls. They are rated 10,000 to 11,500 amperes, for operation at voltages of 12.6 to 16.5 kv.

The 19-inch tube is an extrusion, supplied by Aluminum Company of America (Alcoa), of Pittsburgh. Extruded from electrical conductor aluminum alloy billets, the tube is produced on giant 14,000-ton extrusion presses. It is believed to be the largest extruded tubular conductor ever made.

The 20.5-inch tube is roll- or brake-formed by Delta Star from Alcoa aluminum plate, joined by argon gas MIG welding. A total of over 2,300 feet of bus has been fabricated by Delta Star for three major utility installations. With the exception of insulating supports, the entire bus assemblies are aluminum. Surrounding the bus is a 42-inch-diameter isolated phase housing of continuous-seam-welded, roll-formed 1100 alloy aluminum sheet, $\frac{1}{8}$- or $\frac{1}{4}$-inch thick. The housing assembly is supported by cast aluminum ring supports. The bus is of "telescoping" design, and the flexible leads for the bus joints permit movement at the point of joining. These leads are flexed laminations of 40 aluminum sheets welded to aluminum plate at either end. The all-aluminum combination of housing and ring supports provides continuous ground for the bus.

Lightning Performance of Transmission Lines—III

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THE purpose herein is to present a simplified method of calculating the voltage across the line insulation for a stroke terminating on the tower top and zero tower footing resistance based on the theory and equations derived in two previous papers. For purposes of analysis, the stroke has been resolved into two components: (1) a linear-front flat-top wave of positive charge and associated current that flows upward along the axis of the downward leader at a constant velocity less than that of light, and (2) a linear-front flat-top wave of negative charge and current which is fed into the tower and ground-wire combination.

To determine the voltage across the insulator string caused by the current and charge fed into the tower and ground-wire system, the loop-voltage method of field theory analysis is used. It is shown that the loop-voltage method leads logically and converges into the conventional traveling-wave theory. Fig. 1 (A) shows the voltage across the top insulator string of the single-ground-wire 345-kv AEP-OVEC (American Electric Power-Ohio Valley Electric Corporation) tower as calculated by the loop voltage method and by conventional traveling-wave theory. The values of surge impedances used in traveling wave calculations were determined by equations developed from the loop-voltage method. That is

Z_g = ground-wire surge impedance $= 60 \ln 2h/r_g$

Z_t = tower surge impedance $= 60 \ln \sqrt{2}\, 2h/r_t$

Z_{gc} = mutual surge impedance between ground wire and conductor $= 60 \ln 2h/d$

where h is the ground-wire height, d is the distance from the ground wire to the conductor, and r_g and r_t are the ground-wire and tower radii, respectively. Thus, it is concluded that to calculate the voltage produced by the current and charge fed into the tower and ground wires, conventional traveling-wave theory can be used provided the proper values of surge impedances are used. In view of the wide range of tower surge impedances that appear in the literature, a specific equation justified by theory is an important result of this analysis.

To determine the voltage across the insulator string caused by the charge and current traveling upward from the tower top, the field-cancellation method of field theory analysis is used. From this analysis, the following simplified equation for the voltage across the insulator V_I is

$$V_I = V_c - C_{cg} V_g - K/_t V_t$$

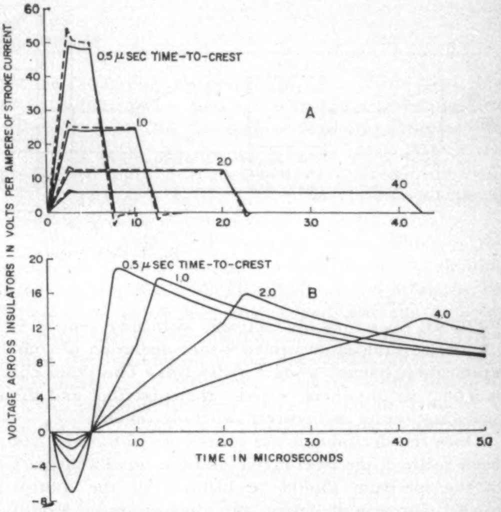

Fig. 1. Voltage across top insulator string of single ground wire AEP-OVEC 345-kv tower for a flat-topped stroke current with a linear front having times to crest as denoted.

——— field theory method; - - - - traveling wave method ($Z_g = 575$ ohms, $Z_t = 280$ ohms, and $Z_{gc} = 137$ ohms); (A) caused by current and charge fed into the tower and ground wires; (B) caused by charge above the tower.

where V_c, V_g, V_t are the average potentials along the conductor, ground wire, and tower, respectively, caused by the charge above the tower. C_{cg} is the coupling factor between the conductor and ground wire and K/t, where t is time, is a correction factor which represents the changing coupling factors between the tower and ground wire and the tower and conductor. By use of the equation given here, the voltage across the top insulator string of the single-ground-wire AEP-OVEC 345-kv tower is calculated and presented in Fig. 1 (B). These values of voltage agree to within 5% with the voltage as calculated by field theory concepts. Thus, it is concluded that this simplified equation can be used to calculate the voltage across the insulator string caused by the charge above the tower.

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Voice Immunity of Tone-Operated Switching Centers

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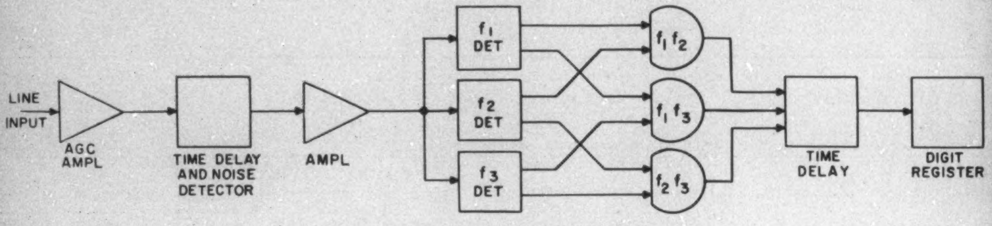

Fig. 1. Block diagram of basic digit detection circuit.

TONE operation of electronic switching centers is the natural outgrowth of 4-wire operation of communication systems using a radio link. The radio circuit may be anywhere between the subscriber and the switching center or between switching centers.

Once the decision to use tone-operated devices had been reached, the next major decision was "what part of the spectrum should be utilized for the control tones?" For ease of design, the obvious answer would be to use a frequency band for control which is separate from the information frequency band. A little reflection shows the fallacy of this thinking. The bandwidth requirement becomes out of proportion to its use. The switching function operates during such a small period of the total circuit holding time that to utilize an expanded bandwith solely for this function is wasteful in an already crowded frequency spectrum. A separate signal band is also expensive from a components point of view since separating filters and signaling circuitry are needed at every switching stage.

For these reasons, in-band supervisory and keying tones that are within the frequency spectrum required for the transmission of intelligence were chosen as the mode of operation.

Laboratory investigation along with research into the available literature led to the decision that each supervisory and keying signal should be composed of a 2-frequency tone. Accordingly, all supervisory functions except "seize" are performed by a 2-frequency compound tone. It was considered unnecessary to protect against false seize initiated by voice due to the nature of telephone operation; that is, the instant the phone is taken off the hook, seize tone is sent out. Any voice tones that could simulate seize will have no effect because that tone is present anyway. As soon as seize tone is detected and dial tone is returned by the switching center the seize detectors are removed from the circuit and any further seize tones on that line will have no effect on the seize detectors. The signal detection circuits were designed for voice immunity simultaneously with the design for operational requirements.

Fig. 1 is a logic block diagram of the basic signal detection circuits. For clarity, only three frequency detectors are shown. Signal reception and detection are accomplished by amplifying the line input with an automatic-gain-control (agc) amplifier which produces an output of 0 dbm for any input signal level in the range of 0 dbm to —30 dbm; and by then detecting the individual control tones by single-frequency-pass-filters followed by storage circuits. Voice guard action is provided by time delay and noise detection circuits.

Voice guard action was checked by counting digit simulations per speech hour. To obtain consistent results throughout the design and testing of the circuit, a standard voice test tape was made. To simulate actual operation as closely as possible, high-fidelity techniques were used for recording and playback. A pulse counter connected to the digit register control gave an accurate count of the digit simulations caused by speech. Final results of voice simulation measured over the environmental range show the following results: (1) at 20 F there are 0 digits per speech hour; (2) at 76 F there are 4 digits per speech hour; and (3) at 135 F there are 16 digits per speech hour.

It is interesting to note that under the same extremes of environmental conditions, the signal-to-noise ratio (S/N) of the circuit varies from 10 db to 5 db due to changes in sensitivity of the Schmitt trigger circuits. This same variation of speech simulations is observed at room temperature when the S/N of the circuit is varied.

At a sensitivity setting of 10 db or better S/N, the circuit is immune against normal voice. As the S/N is reduced, the noise gate becomes increasingly ineffective against voice, and simulations rise rapidly.

Digest of paper 60-820, recommended by the AIEE Communication Switching Systems Committee and approved by the AIEE Technical Operations Department for presentation at the AIEE Summer General Meeting, Atlantic City, N. J., June 19-24, 1960. Published in AIEE *Communication and Electronics*, Nov. 1960.

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A Narrow-Band Peak-Clipping Speech Amplifier

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Overcrowded conditions within the radiotelephone portions of the lower-frequency amateur radio bands often make communication with low signal levels impossible because of interfering signals or noise. A design is presented, based on an analysis of the human voice, of a narrow-bandwidth high-intelligence speech amplifier for amateur and possible general use.

THE advantages of using a narrow passband and peak clipping in speech amplifiers have long been recognized by radio amateurs. A passband from 200 to 3,000 cps (cycles per second) has been considered as being the minimum possible for faithful reproduction of speech. The unit to be described has a passband of from 245 to 2,050 cps; a considerably more narrow passband than is generally assumed necessary if intelligibility is not to be impaired. Tests indicate that this unit produces a highly intelligible signal within a narrow bandwidth in the presence of interference and noise.

AN ANALYSIS OF SPEECH

SPEECH CONSISTS of a wide range of frequencies between 40 and 15,000 cps. The intelligence is contained only in a relatively small portion of the existing spectrum. One measure of intelligibility is the syllable articulation. This measure is defined as the percentage of discrete syllables which may be understood by a listener. Within the band of frequencies which contribute most heavily to the articulation, the peak amplitudes of various frequency components vary greatly with respect to both frequency and time. Also, individual variations between different people are considerable. Because of these characteristics, the problem of determining the frequencies contained in speech and their respective amplitudes must be approached statistically. Fig. 1 shows peak-pressure data as functions of frequency and percentage of time for a typical male voice.

From an examination of Fig. 1, it may be seen that within any band of frequencies the amplitude is not constant. This is an important factor to be considered when designing a speech amplifier. Note that the higher frequencies (above 400 cps) may be emphasized without increasing the highest peak output. Note also that the peaks are reached a small percentage of the time only and that if these peaks are limited, the ratio of the average power to peak power in a speech signal may be greatly increased.

The articulation of a speech signal suffers as the high or low frequencies either separately or simultaneously are removed. Fig. 2 shows the relations between the cutoff frequencies used and the resulting syllable articulation. It may be seen from this graph that the articulation is not appreciably affected until the lower cutoff frequency is raised to 400 cps. Similarly, the high-frequency cutoff may be reduced to 6,000 cps. Using these two cutoff frequencies as an example, the resulting articulation to be expected will be determined from Fig. 2. It may be seen from this graph that if all frequencies below 400 cps are removed, the articulation is 97%. Also, if all frequencies above 6,000 cps are removed, the articulation is 98%. When both ranges are removed simultaneously, the resulting discrete syllable articulation is the product of the two figures stated above, or approximately 95%.

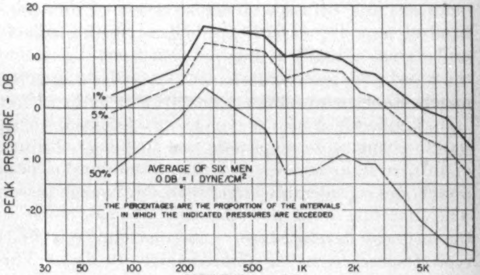

Fig. 1. Peak pressures in speech frequency bands.

Other measures of intelligibility are discrete word and sentence articulations. Again, as in the case of discrete syllable articulation, these measures represent the percentages of discrete words or sentences a listener can comprehend. The correlation between discrete word or sentence articulation and syllable articulation is shown in Fig. 3. Even though some of the sounds which form a word may not be individually recognized

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Essentially full text of paper awarded first prize in the 1958-59 Student Paper Competition of District 3 and second prize in the National Student Paper Competition.

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The author wishes to thank L. J. Hollander, College of Engineering, New York University, and Howard Rollman (Amateur Radio Station W2OLY) for their considerable assistance in the preparation of this article.

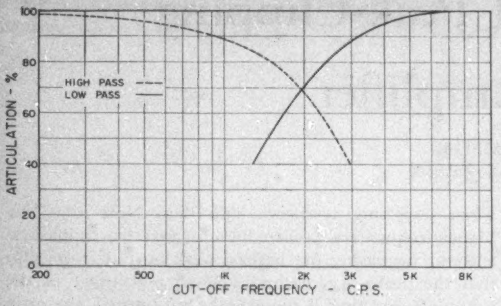


Fig. 2. Syllable articulation for low- and high-passband restriction.

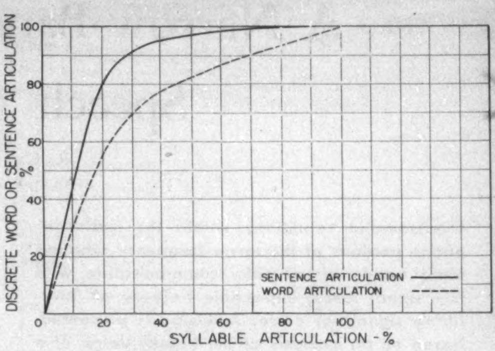


Fig. 3. Syllable articulation vs. discrete word and sentence articulation.

by a listener, the association of various sound groups permits the listener's mind to make an over-all recognition of the word. In the same manner, the mind grasps the complete thought of a sentence even though some of the words may be indistinct. Hence, the sentence articulation is higher than the word articulation for a given bandpass and signal level. Both the word and sentence articulations are higher than the syllable articulation for any given conditions. Using the previous example of a speech signal restricted to a passband of from 400 to 6,000 cps and a resulting syllable articulation of 95%, it may be seen from Fig. 3 that the word and sentence articulations will be approximately 97.5% and 100%, respectively.

As previously stated, a typical speech signal is constantly changing in amplitude and frequency. Because of this, it is to be expected that instantaneous peak powers are considerably larger than the average power. The literature states that the ratio of peak power to the average developed for ⅛-second intervals by a typical speech signal is approximately 10 db.[5, 6] This figure corresponds to a power ratio of 10 to 1. Over long intervals of time (a few sentences) the ratio of peak power to average power is approximately 20 db. This figure corresponds to a power ratio of 100 to 1. Recalling these facts, the following conclusions may be drawn:

If a 10-watt amplifier is to be operated with normal speech input such that the peaks reach 10 watts (assumed to be the maximum undistorted power output), the individual speech sounds such as short words or syllables are likely to develop output powers averaging about 1 watt. Under the same conditions, the average output power over a long period of time will be about one tenth of 1 watt. However, if distortionless output is desired, the amplifier must be capable of producing undistorted output peaks of 10 watts. Hence, it is seen that with a normal speech signal, the power handling capabilities of an amplifier are not efficiently utilized.

METHODS OF OBTAINING GREATER EFFECTIVENESS

TWO METHODS of obtaining greater effectiveness from an audio amplifier are the use of a narrowed frequency bandwidth and the application of peak clipping. If these techniques are employed in the audio section of an AM or double-sideband suppressed-carrier radio transmitter, the resulting signal will require a relatively narrow bandwidth; a feature which is desired if operation is contemplated in crowded bands. Also, the ratio of peak audio power to average audio power may be greatly decreased with a resulting increase in loudness of the received signal as well as an increase of utilization of modulator and modulated amplifier capabilities.

It may be seen from Fig. 2 that virtually all of the intelligence in speech is contained in the frequency band located between 400 and 6,000 cps. From Fig. 1 it is seen that the relative amplitudes of the frequency components within this band decrease with increasing frequency. The average measured rates of decrease are between 5.3 and 6.5 db per octave. The literature states that if the curves of Fig. 1 are truly representative of an average talker, it has been mathematically determined that with a boost of 3 db per octave the resultant increase in loudness would be approximately 7 db with no increase in the peak amplitudes. Hence, the ratio of peak-to-average powers may be decreased by the use of an amplifier with a response that increases with increasing frequency.

An inspection of Fig. 2 reveals that the bandwidth of a speech signal can be reduced to between 400 and 6,000 cps before the articulation suffers. However, with this passband, the signal will sound shrill and high pitched. A general rule of thumb dictates that the product of the low-and high-frequently cutoffs should be approximately 600,000 if a properly balanced signal is desired. Such a signal will have the proper proportion of low and high frequencies so that it will sound more or less natural, depending upon the bandwidth.

Speech can be reproduced within a band as narrow as 1,000 cps. However, with such a greatly reduced bandwidth, the articulation would be undesirably low for most purposes. As a minimum acceptable bandwidth for amateur communications, consider the band of frequencies between 250 to 2,400 cps and the 93 and 99% word and sentence articulations, respectively, which one must accept. Since the sentence articulation is essentially unity, the previously stated bandwidth is considered sufficient for the purpose at hand.

A peak-clipping circuit electronically limits the amplitudes of the output signal. If the peaks of a speech signal are clipped, the ratio of the average power to the peak power of the resulting signal can be greatly increased without loss of intelligence. It is noted that with a clipped speech wave, the average level of modulation may be maintained at a high level in a radiotelephone transmitter without the possibility of over-modulation on peaks (greater than 100%). Thus, the modulator and modulated amplifier capabilities are more effectively utilized. Also, with variations in voice intensity, the modulaton level is held relatively constant when clipping is applied. With a peak clipping level of 4 db in the speech amplifier of an AM or double-sideband radio transmitter, the average information power contained in the sidebands is increased approximately 2.6 db compared to the sidebands of unclipped speech of identical peak amplitudes. Similarly, the use of 11 db of peak clipping increases the information power approximately 6 db.[2]

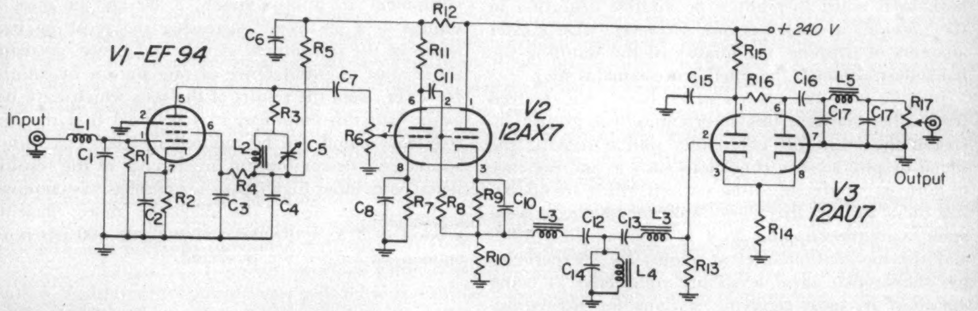
Although a moderate amount of clipping does not decrease the intelligibility of the resulting signal, it does produce high-order harmonics. With both positive and negative peaks of a sine wave clipped 3 db, the following odd harmonics and their respective amplitudes were found with the aid of Fourier analysis to be: (a) third harmonic—17.5 db below fundamental; and (b) fifth harmonic—30.3 db below fundamental.

Because of generation of harmonics due to clipping, it is necessary to use a low-pass filter following the clipper to remove the undesired frequencies which may be generated outside of the intended passband.

It is possible to employ as much as 25 db of peak clipping before intelligibility suffers appreciably. However, it has been observed by this author that a loss of naturalness results if more than 10 db of peak clipping is used. The benefits obtained from peak clipping illustrate the law of diminishing return. With increasing clipping, the amplitudes of the generated harmonics increase and the increase of information power per increase of clipping level decreases. Before clipping can be used, the speech signal must be amplified several times more than would be necessary for unclipped speech. Hence, the hum and noise introduced in the amplifier preceding the clipper must be lower than the tolerable level in conventional amplification by a factor equal to the amount of clipping which will be applied.

EXPERIMENTAL RESULTS OF A TYPICAL SYSTEM

A SPEECH AMPLIFIER employing the aforementioned desirable characteristics was constructed and tested. A schematic diagram of the circuit which was used and its over-all frequency response are shown in Figs. 4 and 5, respectively. This amplifier was given its final tests by using it in the application for which it is primarily intended. A typical amateur radio installation consisting of a commercially constructed Elmac *AF-67*



C_1 = 100 MMF DISC
C_2, C_8, C_{10} = 25 MF, 25 V.
C_3 = 0.047 MF, 450 V.
C_4, C_6, C_{15} = 16 MF, 450 V.
C_5 = 300 MMF COMPRESSION TYPE TRIMMER
C_7, C_{11} = 0.005 MF DISC
C_{12}, C_{13} = 1.15 MF (1%) 600 V.
C_{14} = 0.297 MF (1%) 600 V.
C_{16} = 0.10 MF DISC
C_{17}, C_{18} = 47 MMF DISC
L_1 = 2.5 MH. R.F.C.
L_2, L_5 = 20 HY. (STANCORE C-1515)
L_3 = 386 MH. (1%) V.I.C. - 4
L_4 = 150 MH. (1%) V.I.C. - 7
R_1 = 2.2 MEG. 0.5 W.
R_2 = 2.5K. 1W.
R_3 = 100K. 1W.
R_4 = 1.0 MEG. 1W.
R_5 = 100K. 2W.
R_6 = 500K. POT. (CLIPPING LEVEL)
R_7 = 4.7K. 1W.
R_8 = 470K. 0.5 W.
R_9 = 1.6K. 1W.
R_{10} = 3.0K. 1W. (1%)
R_{11} = 470K. 0.5 W.
R_{12} = 22K. 0.5 W.
R_{13} = 510 OHMS 1W. (1%)
R_{14} = 1.5K. 2W.
R_{15} = 47K. 2W.
R_{16} = 56K. 0.5 W.
R_{17} = 500K. POT. (OUTPUT LEVEL)

Fig. 4. Schematic diagram of amplifier.

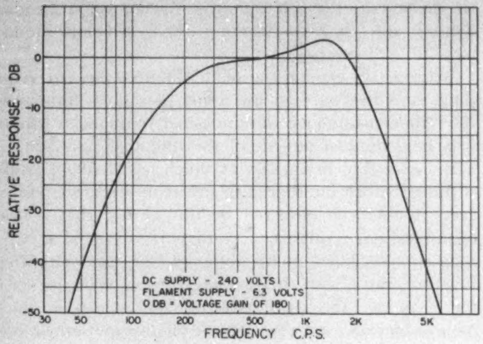


Fig. 5. Over-all frequency response.

transmitter operating in the 10-meter amateur band was used. The output of the speech amplifier was used to excite the driver stage immediately before the modulators in the Elmac with the previous audio stages disabled. An Astatic *D-104* crystal microphone was used at the input of the speech amplifier.

After having contacted more than 100 different stations, not one report of an abnormal sounding signal has been received while the reporting station has remained ignorant of the fact that an unusually narrow bandpass was being used. Hence, it is believed that a bandpass of from 245 to 2,050 cps at the half power points (Fig. 5) is sufficient for the transmission of speech without excessive degradation of the signal quality, providing high-frequency emphasis is employed. Clipping levels in the order of 8 db or less have been noted to produce no audible distortion in the opinions of most persons. However, with greater amounts of clipping, the quality of the resulting signal suffers although the intelligence remains high.

Judging from the reports which have been received from other stations, this speech amplifier greatly increases the possibility of another station copying the signal despite adverse conditions such as the presence of noise or interference from stations which are operating on a nearby frequency. Most of the tests were made with the clipping level at approximately 6 db and the modulation level at about 90%. Experience has shown that these levels are considered as being optimum by most receiving stations for the equipment being used.

Local stations with both broad and narrow passband receivers have reported no noticeable distortion products on the edges of the sidebands. Hence, it is possible with this speech amplifier to operate within about 4 kc of another station without causing that station any interference because of wide sidebands or distortion products due to overmodulation.

While in contact with a distant station during a period of poor atmospheric conditions, it was reported by that station that it was possible to recognize every word distinctly even though the carrier level of the received signal was below the existing noise level at that receiving location. This report is not unique. Similar reports have been received from a number of mobile stations which usually must contend with a higher noise level than is generally encountered at a fixed location station with a more elaborate receiving system.

The narrow, clean sidebands produced by an AM (or by a double-sideband suppressed-carrier) transmitter using this speech amplifier may be attributed to the sharp high-frequency cutoff characteristic of the amplifier. Because of the fact that the resulting signal can be readily copied under conditions of low-signal levels and noise, it is believed that the sidebands are efficiently utilized although they are relatively narrow. Clipping action keeps the average modulation high and the high-frequency emphasis tends to fill out the sidebands more completely and increase the speech power contained in them without increasing the peak modulation level. These features improve the signal-to-noise ratio at the receiving station.

CONCLUSIONS

IT IS BELIEVED that the use of a narrow bandpass speech amplifier which incorporates peak clipping greatly increases the possibility of maintaining reliable contact with another station during periods of adverse conditions. Clipping levels at 6 to 8 db provide a considerable increase in the average modulation level, and hence, a louder sounding signal, without unexceptably high distortion or any loss of intelligence.

As a result of crowded band conditions, radio amateurs have limited high-frequency response in audio equipment to approximately 3,000 cps in most instances as a means of decreasing the resulting bandwidth of the transmitted signals and hence, decreasing the chance of interference of one station by another. However, from the results of the tests which have been made with this amplifier, it is believed that the high-frequency cutoff can be reduced to 2,000 cps without appreciably decreasing the intelligence of the resulting signal, providing high-frequency emphasis is employed.

In order to utilize the sidebands more efficiently, a boost of 3 to 4 db per octave above 500 cps is recommended within the passband.

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Direct Calculation of Transmission Loss Equation—I

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MEMBER AIEE

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A program for the calculation of loss formula coefficients has now been written using an approach which is not limited by analog techniques and which utilizes the unique capabilities of digital computers. The program provides a means for proceeding automatically from one step to the next during the calculation as well as greatly simplifying the preparation of the necessary data.

The new digital computer method directly determines the impedances between all the sources of the system and the hypothetical load center (reference-frame-3 quantities) without any intermediate matrix operations by applying the necessary mathematical constraints to the network. The reference-frame-3 equation is

$$m\ \boxed{E_{Gm}-E_L} = m\ \overset{n}{\boxed{Z_{m-n}}}\ n\ \boxed{i_{Gn}}$$

where

E_{Gm} = voltage of source m
E_L = voltage at hypothetical load center
Z_{m-n} = self and mutual impedances between source and hypothetical load
i_{Gn} = source current n

The reference-frame-3 impedances Z_{m-n} are determined digitally one column at a time by supplying all the loads by a single source at a time. The Z_{m-n} impedances are projected to the loss formula coefficients (B coefficients) by using a Q/P value (s value) directly determined from the frame-3 self-impedances.

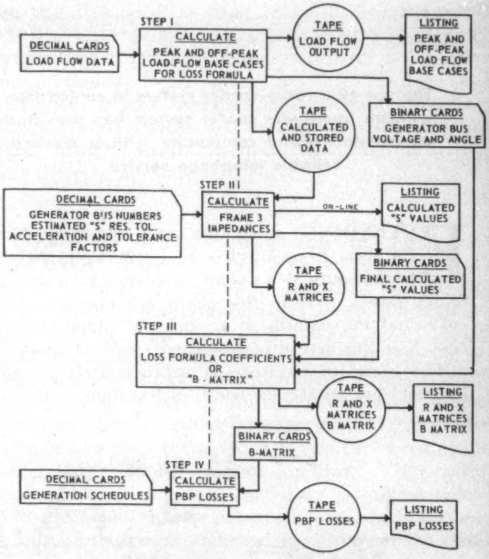
STEP I
DECIMAL CARDS
LOAD FLOW DATA
CALCULATE
PEAK AND OFF-PEAK
LOAD FLOW BASE CASES
FOR LOSS FORMULA
TAPE
LOAD FLOW
OUTPUT
LISTING
PEAK AND
OFF-PEAK
LOAD FLOW
BASE CASES
TAPE
CALCULATED
AND STORED
DATA
BINARY CARDS
GENERATOR BUS
VOLTAGE AND ANGLE
STEP II
DECIMAL CARDS
GENERATOR BUS NUMBERS
ESTIMATED "S" RES. TOL.
ACCELERATION AND TOLERANCE
FACTORS
CALCULATE
FRAME 3
IMPEDANCES
ON-LINE
LISTING
CALCULATED
"S" VALUES
BINARY CARDS
FINAL CALCULATED
"S" VALUES
TAPE
R AND X
MATRICES
STEP III
CALCULATE
LOSS FORMULA COEFFICIENTS
OR
"B - MATRIX"
TAPE
R AND X
MATRICES
B MATRIX
LISTING
R AND X
MATRICES
B MATRIX
BINARY CARDS
B-MATRIX
STEP IV
DECIMAL CARDS
GENERATION SCHEDULES
CALCULATE
PBP LOSSES
TAPE
PBP LOSSES
LISTING
PBP LOSSES

Fig. 1. Flow chart of loss formula program.

A flow chart of the loss formula program is shown in Fig. 1. Step I provides complete load flow results for peak and off-peak load conditions and calculates data needed in succeeding steps. In Step II, loads are analyzed for type and the appropriate calculations for each type of load are made. Reference-frame-3 impedances are calculated one column at a time by an iterative circuit solution. Improved values of s are computed and printed on line for comparison with the original estimates (or previous calculated values) of s. If the maximum change in s from the previous value is not within a desired tolerance, new calculations can be made easily until the desired accuracy is reached. The calculation of the B-matrix in Step III is performed by using the frame-3 impedances and s values obtained from Step II, and generator bus voltages and angles calculated during the load flow of Step I. The final step in the program (Step IV) is the calculation of losses using the newly formed B-matrix and P-vectors available from previously calculated load flow cases. Printed results of the calculations include complete load flow results for the base peak and off-peak load cases, lists of the calculated s for each generator after each iteration in the frame-3 impedance calculation; the diagonal and half of the off-diagonal terms of the B-matrix and a listing of the PBP losses for as many cases as desired.

The new program was used recently in the determination of a loss formula for the entire American Electric Power Service Corporation (AEP) as well as formulas for each of the three operating divisions of the system. Application of these new techniques to the AEP system resulted in significant savings in computation time and total cost for developing a loss formula (1) by providing an automatic means of determining s factors and thus eliminating the need to carry out large series of load flow cases and (2) by significantly reducing engineering effort in recording and transcribing data and results. Once the base load flow data was assembled and the base load flow case satisfactorily completed, the calculations proceeded automatically from step to step without manual intervention, thereby reducing the chance of errors.

Digest of paper 60-367, recommended by the AIEE System Engineering Committee and approved by the AIEE Technical Operations Department for presentation at the AIEE Summer General Meeting, Atlantic City, N. J., June 19-24, 1960. Published in AIEE *Power Apparatus and Systems*, Dec. 1960.

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Providing 150-Mc Telephone Service to North Carolina's Ocracoke Island

M. B. McMILLAN
MEMBER AIEE

The use of a radio-carrier system in conjunction with an open-wire carrier system has provided an isolated island community with a modern, reliable telephone service.

EXTENDING along the east coast of North Carolina from Manteo in the north to Atlantic in the south lies a chain of islands known as the Outer Banks. Within this chain are Hatteras, Ocracoke, and Portsmouth. It is with the island of Ocracoke that this article is concerned.

The island of Ocracoke is approximately 16 miles long and has an average width of less than 1 mile. On the north is bounded by Pamlico Sound and Hatteras Inlet; on the east, by the Atlantic Ocean; on the south, by the ocean and sound; and on the west, by the sound only. The island may be reached from the north by automobile over paved roads on Hatteras and Ocracoke Islands and by State-operated ferries across Oregon and Hatteras Inlets. Mail boats operating daily between Atlantic and Ocracoke offer passenger service from the south, and private plane service is available from several mainland cities. The island is inhabited by approximately 850 residents, most of whom live in Ocracoke Village at the southern end of the island. The village is adjacent to the inlet and is built around a salt-water lake. The pursuits of the sea occupy most of the island's 850 people.

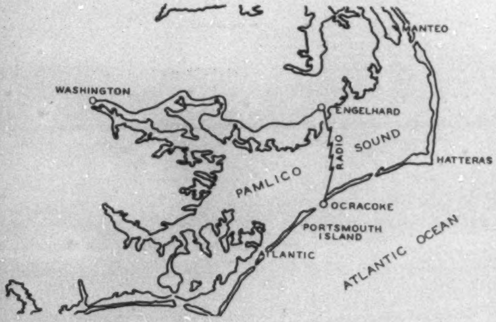

Fig. 1. Map showing location of Ocracoke Island, N. C.

Fig. 2. Radio transmitter–receiver bay.

The only communications prior to 1955 were the United States Coast Guard facilities at Ocracoke Village, which offered the islanders limited communications in cases of emergency. In 1955, telephone service was requested for Ocracoke Island. The nearest telephone exchange to the island is the unattended dial office at Engelhard, N. C., approximately 28 air line miles distant, and the nearest serving toll center is located in Washington, N. C., approximately 97 air line miles distant; see Fig. 1.

Surveys of the families and business establishments on the island indicated that facilities which would provide a total of three communications channels for off-the-island communications and a 100-line dial office located at Ocracoke Village should be sufficient to satisfy demands for service. Comparative cost studies were made utilizing (1) radio facilities between Ocracoke and Washington, (2) radio facilities between Ocracoke and Engelhard and carrier superimposed on existing wire-line facilities between Engelhard and Washington, and (3) submarine cable between Ocracoke and Engelhard and carrier superimposed on existing wire-line facilities between Engelhard and Washington. This study indicated that the three trunks between the proposed Ocracoke central office and the serving toll center at Washington could be most economically provided by the use of multiplexed radio between

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Ocracoke and Engelhard, and by carrier superimposed on existing wire-line facilities between Engelhard and Washington.

The desire to keep the antenna height to a minimum and the expected reflection effects on the 28-mile overwater path made the 152- to 162-mc frequencies the most attractive. After a survey of existing stations operating in the area in the 152- to 162-mc frequencies, a frequency of 152.57 mc was selected for Ocracoke and a frequency of 157.83 mc for Engelhard.

The wire-line section between Engelhard and Washington, having previously been transposed for carrier operation, offered a very economical layout for a carrier system. A conventional 4-channel compandored open-wire carrier system was established in this section with terminals at Washington and Engelhard and with intermediate repeater located at Belhaven, N. C. A room was constructed in the rear of the hotel to house the 100-line dial office and the multiplexed radio equipment. The local cable plant was constructed on the island, radio and wire-line facilities were connected, and on June 15, 1956, telephone service was established to Ocracoke Island.

RADIO EQUIPMENT

Packaged station combinations modified for extended bandwidth, as shown in Fig. 2, operating in the 150-mc frequency range, were used for the radio facilities. This combination included a transmitter, a receiver, and a carrier-operated relay, tropicalization-treated and mounted in an indoor cabinet. The base-band frequency response of 0.2 to 11.2 kc allows for the multiplexing of a voice-frequency channel and two single-sideband suppressed carrier channels, together with three associated signaling channels. The broadbanding of this equipment, which previously had been available on a single-channel basis, was accomplished through modification. This modification provides a frequency-modulation characteristic, extended bandwidth, the elimination of the peak deviation limiter, and the addition of feedback in the base-band amplifier. The units are phase-modulated, have a 50-watt r-f output, input and output impedances of 600 ohms, and continuous input and output level control. For continuous duplex operation, the operating frequencies of the transmitter and receiver are separated by 5 mc. Actual operating frequencies, as well as transmitted levels, are shown in Fig. 3.

ANTENNAS

Each radio terminal utilizes one corner reflector with special iridite treatment. These antennas have an approximate gain of 7.5 db compared to a dipole with a front-to-back ratio of about 15 db. The Engelhard reflector is mounted on a 150-foot guyed tower as shown in Fig. 4. The Ocracoke Island reflector is mounted on a 65-foot pole. Reinforced guying is used for protection against the hurricane-force winds which are often present along the coast. The vertically polarized antenna is connected to two cavity resonator filters with *RG-8U* transmission line. The cavity resonator filters suppress transmitter extraband radiation and avoid receiver desensitization, which permits simultaneous transmission and reception on the common antenna. The cavity resonators are mounted on a special rack attached to the wall and are connected to the radio terminals with type *S-450* transmission lines.

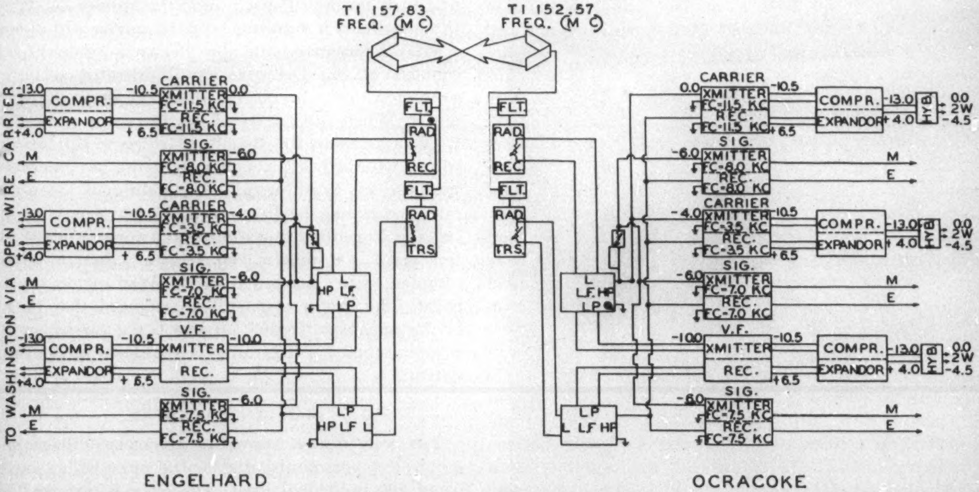

Fig. 3. Block diagram of radio-carrier system with transmission levels. All levels in db deferred to 1 milliwatt with 1,000-cycle tone at zero transmission level point.

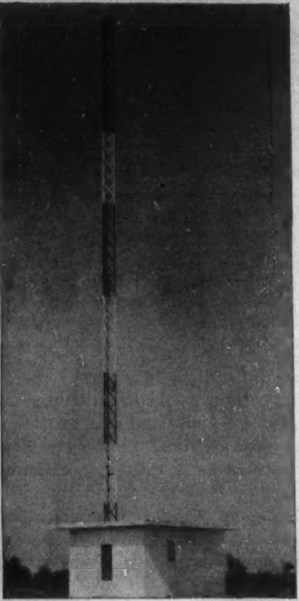

Fig. 4 (*left*). Engelhard dial central office building and antenna structure.

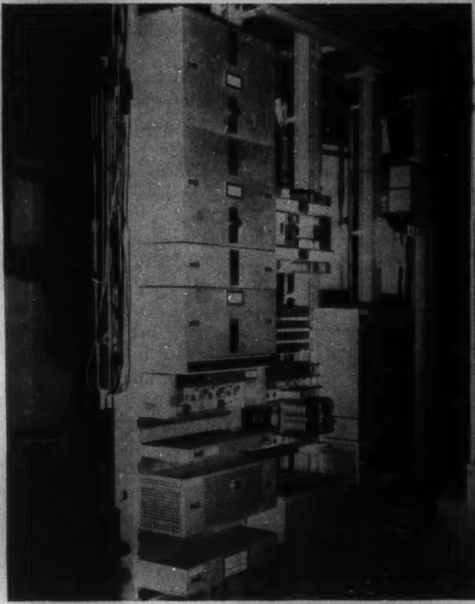

Fig. 5 (*right*). Radio multiplex equipment bay.

RADIO MULTIPLEX EQUIPMENT

Telephone carrier channels, as shown in Fig. 5, provide for application of three telephone message channels to the broad-band radio facilities. The system consists of one voice-frequency channel, two carrier-derived channels, and three signaling channels. The voice-frequency channel occupies a band of frequencies between 200 and 3,000 cycles per second. Two additional amplitude-modulated single-sideband suppressed carrier channels are derived by modulation of voice frequencies of 300 to 2,700 cycles. Channel 2 transmits and receives on the upper sideband of 3.5 kc and Channel 3 transmits and receives on the lower sideband of 11.5 kc, as shown in Fig. 6. The block diagram of three channels of the radio-carrier system, including compandors and voice-frequency terminating units, are shown in Fig. 3. Signaling for dialing and supervision on the three channels are transmitted and received at carrier frequencies of 7.5, 7.0, and 8.0 kc for channels 1, 2, and 3, respectively. Each channel utilizes a compandor unit to provide an effective increase in signal-to-noise ratio.

RADIO SYSTEM ALARMS AND CONTROLS

The alarms and controls of the radio system appear as both audible and visual alarms on the Washington, N. C., central office switchboard with instructions to authorized personnel for their interpretation and operation. A red pilot light indicates when the carrier is on or off. Red light on indicates the carrier is on while red light off indicates the carrier is off. In addition to this visual alarm, an audible alarm will sound to indicate the carrier is off.

The method used to turn the transmitter carriers on and off is as follows: The contacts of a switch located on the Washington switchboard are extended over an open-wire carrier signaling facility to Engelhard. These facilities are used to operate a relay which will turn the Engelhard transmitter carrier on. When the Engelhard transmitter is on, its carrier will operate a relay associated with the Ocracoke receiver. The contacts of the Ocracoke carrier-operated relay are connected to the keying circuit of the Ocracoke transmitter. When the carrier of the Ocracoke transmitter is on, a relay in the Engelhard receiver will operate which will activate a signal light on the operator's position in Washington. An additional open-wire carrier signaling facility is utilized between Washington and Engelhard, for control and supervision of the Engelhard transmitter and receiver, thereby giving complete system control from the Washington control point. The carrier system is so arranged that failure of the open-wire facility on which the carrier system is superimposed will result in a shutdown of the radio system.

DIAL CENTRAL OFFICE

The new office located at Ocracoke Village is a step-by-step community dial central office with a capacity of 200 individual lines. The office is arranged for normal 2-letter 5-digit dialing and is identified as WAverly 8. While local calls are made on the 2-letter

5-digit basis, incoming and outgoing calls to distinct points must be routed through the Washington central office. Island subscribers may reach the Washington operator by dialing "0."

POWER

THE BASIC POWER for the radio-carrier system is single phase, 115 volts a-c, 60 cycles. The village of Ocracoke generates its own power, using diesel-driven generator facilities. The power plant was installed during World War II by the U. S. Navy to provide power for Navy installations on the island. The facilities were obtained by the islanders after the war and expanded to serve the village.

A privately owned ground return power system serves the town of Engelhard. This system operates without a neutral conductor and uses the earth for the return path. Emergency a-c power for the Engelhard office is provided by diesel-driven automatically controlled alternators with a single-phase 60-cycle output of 7.5 kw at 240/120 volts a-c. In the event of a power failure, the generator will start automatically and will continue to operate until the power is restored.

CONCLUSIONS

THE USE of the radio-carrier system in conjunction with the open-wire carrier system and the dial office has provided the isolated community on Ocracoke Island with a modern, reliable telephone service. The acceptance of this service by the islanders is evidenced by the fact that 50 additional lines have been installed since the initial installation was made.

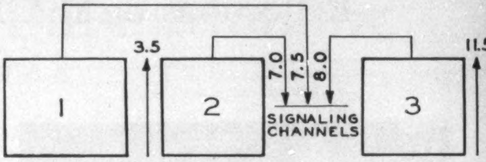

Fig. 6. Radio multiplex channel allocations.

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Miami Airport Features Outstanding Lighting

Among the important innovations at the handsome new Miami (Fla.) International Airport are outdoor lighting features provided for users of both aircraft and ground transportation. Overhead lighting in the huge auto parking area includes some specially designed units never before installed in any airport. Functional as well as decorative, these installations provide clear visibility with a minimum of glare, and employ powerful, long-life fluorescent and mercury light sources.

The General Electric Company's Power Groove fluorescent lamps provide lighting for the service areas on each side of six "terminal fingers" extending from the central terminal building. The lamps are mounted, in pairs, in fixtures supplied by Pfaff & Kendall. These units supply comfortable but effective illumination for airline passengers entering and leaving the 84 gate positions, and for the aircraft servicing crews.

At the mammoth automobile parking area across from the terminal entrance, the lighting is accomplished by use of 400-watt General Electric color-improved mercury lamps. Well-distributed illumination here facilitates the safe movement of traffic, and aids pedestrians in making their way to and from the terminal building.

Maurice Connell & Associates were the airport lighting engineers. Rader & Associates were the design engineers for the parking areas.

Reflections on the Traffic Usage Recorder

R. A. BAUERFELD

Fig. 1. Author and traffic usage recorder frame.

A MAJOR problem in the field of telephone traffic engineering is the gathering and summarization of usage data. This is also the first step in the process of providing the telephone subscriber with the proper type and quantity of telephone facilities to give a satisfactory grade of service, which is the general responsibility of the traffic engineer. Prior to the introduction of the Traffic Usage Recorder (TUR), sufficient accurate usage data was most difficult to obtain.

In 1955, the TUR developed by Bell Telephone Laboratories and manufactured by Western Electric Company, became available to the telephone industry. The unit, an equipment usage measuring device, is designed for a large capacity and is capable of testing up to 3,600 items of equipment almost simultaneously. Controlled by a program timer, the TUR will scan the equipment being tested and score the results on registers automatically photographed by cameras at predetermined intervals.

The Southern New England Telephone (SNET) Company, cognizant of the potential value of the TUR, was one of the first companies to adapt a comprehensive use of the recorder and had 55 units in operation at the close of 1959. All major local and toll offices are being equipped with the TUR, and both equipment and interbuilding trunking usage is measured.

Although basic data for traffic engineering had been made readily available, it became evident that the development of administrative procedures was required to keep the over-all cost of gathering data at a minimum. Inasmuch as data collected was to be used for other than engineering purposes, and clerical work loads had to be estimated, TUR operation schedules became essential. The schedules had two results: a periodic review of the basic data required to engineer equipment satisfactorily, and a greater degree of TUR utilization.

Manual data compilation methods proved inadequate and procedures have been developed by the SNET Company by which the readings of the automatically photographed TUR registers are processed by IBM machines at the SNET Company data-processing center. The data-processing method is basically one whereby edited TUR film register readings are transferred by a key punch operator into IBM card decks containing identification codes gang punched from a master deck. The reading differences are computed and printed on a report. In addition to differences, averages and totals are also computed. From the completion of the key punch operation to the final report, all steps are accomplished by machine. The report not only indicates actual loading of the various types of equipment, but provides a basic data record and permits a constant check on the operation of the TUR itself. Copies are easily printed and furnished quickly to all who have need for results.

TUR data obtained for traffic engineering purposes are being used primarily to determine various equipment loadings as a base in the provision of facilities. The increased availability of basic data in quantity and reliability lessens the requirement for applied judgment to unknowns, and decreases the expected margin of error and resultant safety factor in estimating future equipment loadings. Inasmuch as a major portion of invested capitol is in the vast amount of call-carrying central office equipment and outside plant, more efficient utilization of facilities will result in substantial dollar savings. It is in this respect that the TUR has realized and will continue to realize savings many times its monetary value.

In addition to improved utilization, TUR data are being used to analyze existing traffic characteristics that may suggest future engineering concepts and techniques. Special studies showing load service relationships under various conditions have been undertaken with remarkable success. Also, traffic patterns and subscriber habits influencing the loading within an office are being studied.

Although this report highlights traffic engineering with the TUR, it should be noted that TUR data are being used very successfully by local equipment administrators to balance loadings by proper equipment assignments. TUR results are also aiding in the equitable distributions of intercompany toll revenues.

Digest of 60-819, "Reflections on the Traffic Usage Recorder with Emphasis on Traffic Engineering," recommended by the AIEE Communication Switching Systems Committee and approved by the AIEE Technical Operations Department for presentation at the AIEE Summer General Meeting, Atlantic City, N. J., June 19-24, 1960. Published in AIEE *Communication and Electronics*, Nov. 1960.

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A Transistorized Pulse Monitor

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A device is described that continuously monitors the pulse rate of an individual on the operating table. This aids the anesthesiologist in keeping a constant check on the condition of the heart, a task that was formerly impossible.

ONE of the major areas of concentration in the medical profession has been the heart. This vital organ deserves great attention. Today the linking of the electronics field with that of the medical field is enabling doctors and researchers the world over to have a better understanding of the heart and its functions. Electrocardiographs, cardiac pacemakers, and a device for starting an arrested heart with a very small voltage are but a few of the accomplishments in this area.

In the past, few attempts have been made to aid the anesthesiologist in the operating room in keeping a constant check on the condition of the heart. In most cases, the doctor and anesthesiologist have had to rely on others to take an actual count of the individual's pulse. Because of this, it was impossible to keep a constant check on the pulse rate of an individual.

It was felt that if a device could be developed which would give both a visual and aural indication of the average pulse rate of an individual, it would be an invaluable aid to the anesthesiologist and others in the operating room. If such a unit were available, not only could a constant automatic vigil be kept on the pulse, but one or more people could be released from this job to do something else.

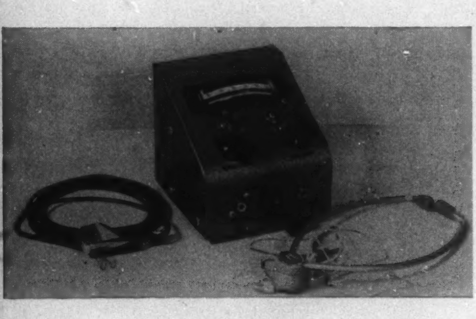

Fig. 1. Pilot model.

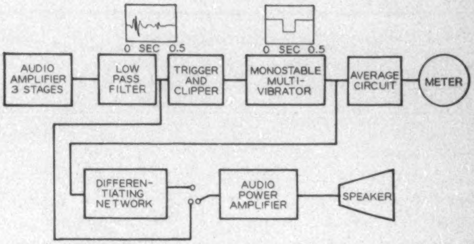
0 SEC 0.5
0 SEC 0.5
AUDIO AMPLIFIER 3 STAGES
LOW PASS FILTER
TRIGGER AND CLIPPER
MONOSTABLE MULTI-VIBRATOR
AVERAGE CIRCUIT
METER
DIFFEREN-TIATING NETWORK
AUDIO POWER AMPLIFIER
SPEAKER

Fig. 2. Block diagram of pulse monitor.

DESIGN

IT WAS FOUND that there were many basic requirements which had to be considered in undertaking this project. Any such device, in order to have any practical use, must be compact in size, rugged, highly accurate, and easy to operate. All of the components used must be of the highest quality, thus ensuring a long life for the unit. It was also found that the danger of electric arc must be taken into consideration, since in the operating room the presence of even a small arc might cause a disastrous explosion.

Transistors rather than vacuum tubes have been used in an effort to fulfill these requirements. The pilot model (Fig. 1), has been assembled in a sloping panel cabinet, 4¼ inches wide, 4 inches deep, and 4 inches high. Since transistors are inherently more rugged than vacuum tubes, the limitation on ruggedness of the unit is, therefore, determined solely by the meter, which, if desirable, might be shock mounted. The circuits used in this unit are relatively independent of the character-

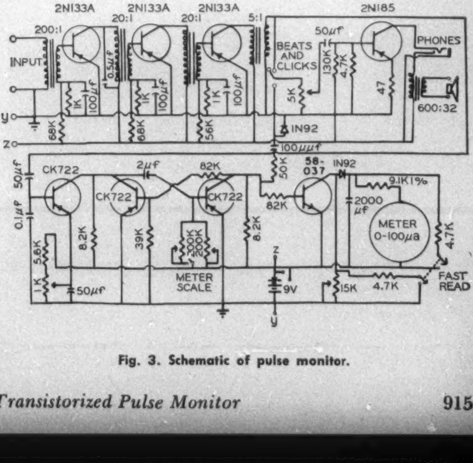
2N133A
2N133A
2N133A
2N185
200:1
20:1
20:1
5:1
INPUT
0.5μf
1K
100μf
68K
68K
56K
BEATS AND CLICKS
50μf
130K
4.7K
5K
47
PHONES
600:32
IN92
100μμf
y
z
CK722
CK722
CK722
2μf
82K
82K
50K
58-037
IN92
9.1K1%
2000 μf
METER 0-100μa
4.7K
FAST READ
50μf
0.1μf
5.6K
1K
50μf
8.2K
39K
200K
200K
METER SCALE
8.2K
9V
15K
4.7K

Fig. 3. Schematic of pulse monitor.

Essentially full text of the prize winning paper in the District no. 1 Student Papers Competition, 1958-59.

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The authors acknowledge the invaluable aid given by the following: C. C. Davies, A. R. Martin, G. W. Reed, Barbara Richards, W. J. Strong.

istics of the individual transistors used. Reliability is excellent. A "ballpark" estimate on the mean time to failure (MTTF) of the unit, excluding the battery, is approximately 15,000 hours. Changes in battery voltage of up to 15% have not affected the operation of the unit, but the meter accuracy suffers to a small extent. The use of transistors also gives a marked increase in total life as compared with vacuum tubes. No danger of electric arc exists because only 9 volts at approximately 10 milliamperes (ma) is required for power. The sloping panel cabinet and the edge-ruled meter were chosen because it was felt that viewing would be easier from a variety of angles. All controls, which have been kept to a minimum, are clearly marked and strategically located for ease of operation.

Two types of pick-up devices may be used with this unit. A sensitive microphone such as the recently developed electronic stethoscope or the electrodes commonly used in conjunction with electrocardiographs may be used with satisfactory results.

THE BLOCK DIAGRAM

Turning to the block diagram (Fig. 2), it is seen that a signal picked up by either of the aforementioned methods is amplified by the three stages of audio amplification. This is done in order to obtain a signal of sufficient magnitude to trigger the control circuits. The graph shown above the low-pass filter is a typical heartbeat obtained with an inexpensive microphone feeding into an audio amplifier which in turn was connected to a Brush ink graph recorder. The rise time of the largest pulse of this waveform corresponds to a frequency of approximately 100 cycles per second (cps). Therefore, any frequencies in the signal which are higher than 100 cps are not needed and, in fact, could impair the operation of this unit. Because of this, we have employed a low-pass filter to reject this unwanted noise; the cut-off frequency of the filter being approximately 150 cps.

The clipper is used to reject all residual noise which occurs between beats of the heart, ensuring good triggering of the monostable multivibrator on each beat.

The pulse width of the multivibrator is 133 milliseconds. For such slow repetition rates as are encountered with heartbeats, an undamped meter would fluctuate severely. Therefore, an averaging circuit is employed to damp out these fluctuations and give a relatively constant reading. The average voltage appearing across the meter circuit is altered by the pulses coming from the multivibrator, since the length of each pulse (pulse width) is fixed. The negative pulses, as shown on the block diagram, are inverted in the average circuit. It is, therefore, quite evident that the more pulses received in a given period of time, the higher the reading will be, and vice versa.

A variety of outputs are available with this unit. A true reproduction of the heartbeat as picked up by the microphone is sent through a conventional power amplifier and can be heard through either the speaker in the side of the monitor or an external speaker. Earphones might be desirable when listening to such a reproduction, and so an output for this purpose has been provided. If electrodes are used as the pick-up device, this same output could be fed into an oscilloscope or electrocardiograph for a visual presentation of the condition of the heart. Provision has also been made for monitoring each heartbeat aurally with a single click representing each beat. This is accomplished by taking the output of the multivibrator, differentiating it, and sending the resulting click through the power amplifier. Again, either a speaker or earphones may be used in listening to this type of output.

THE CIRCUIT DIAGRAM

Transformer input and coupling for the three stages of audio amplification (Fig. 3) are employed for a specific reason. Transistors are inherently noisy. Cascading more than three stages raises the noise level beyond that which can be tolerated in this unit. The input impedance must be high, and, consequently, an additional transistor would have been required for impedance matching. Transformer coupling provides a maximum amount of gain per stage. These three stages provide as much gain as four stages of *RC* or direct-coupled amplifiers. Direct coupling gives rise to stability problems, and *RC* coupling would have required very large coupling capacitors because of the low-frequency re-

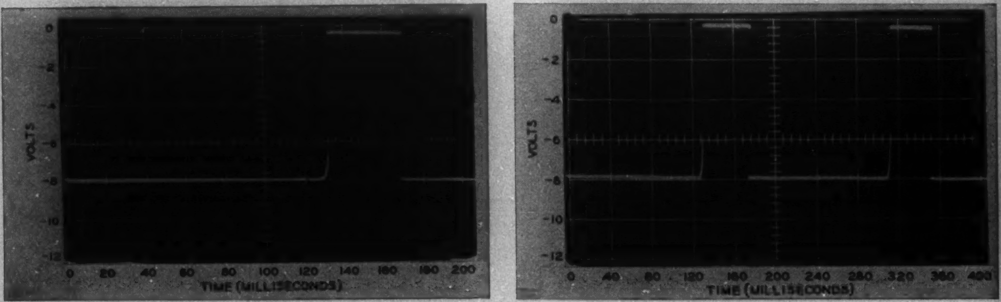

Fig. 4. 133-millisecond pulse of multivibrator on XI scale. (*Left*) single pulse; (*right*) double pulse.

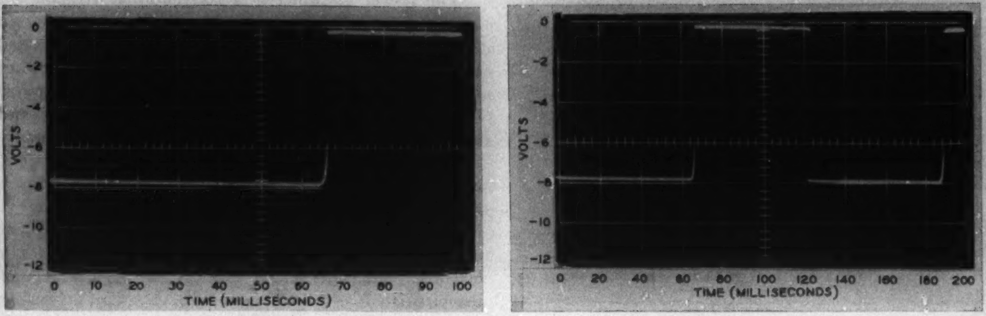

Fig. 5. 67-millisecond pulse of multivibrator on X2 scale. (*Left*) single pulse; (*right*) double pulse.

sponse requirements. The *2N133A* transistors used are special low-noise types manufactured by Raytheon. The d-c operating point of each stage is dependent on the current rating of the transformers used (0.5 ma for the first two stages and 1 ma for the third stage). The 0.5-microfarad capacitor shunted across the primary of the transformer at the output of the first stage forms a low-pass filter which attenuates all frequencies above about 150 cps.

Conventional triggering methods cannot be used because of the slow rise time of the incoming signal. A rather brute-force technique is used here. The trigger transistor and the left-hand transistor of the multivibrator share a common load resistor. A small signal at the base of the trigger transistor will literally pull the multivibrator into operation. The bypassed voltage divider at the emitter of the trigger transistor caused this stage to act as a clipper also. Residual noise between beats will therefore not affect the operation of the trigger and the multivibrator. The 1,000-ohm potentiometer is accessible on the front panel and is used to adjust the sensitivity of the unit. The 0.1-microfarad capacitor provides a degree of filtering out of high-frequency noise. The 50-microfarad capacitor is used so that the trigger clipper transistor will not be cut off when the sensitivity control is advanced to its maximum position. The transistor would be cut off under these conditions if direct coupling were used.

The design of the monostable multivibrator is straight forward. The meter scale switch selects one or the other of two pulse widths. With a pulse width of 133 milliseconds (Fig. 4), the meter reads full scale when the repetition rate is 100 beats per minute. With a pulse width of 67 milliseconds (Fig. 5), the meter reads full scale when the repetition rate is 200 beats per minute. In normal usage, the meter should not be called upon to read more than 150 beats per minute. The meter scale switch is marked X1 and X2 meaning that the meter can be read directly or multiplied by a factor of two when repetition rates over 100 beats per minute are encountered.

One will notice that a *58-037* n-p-n switching transistor, manufactured by International Business Machines Corporation, was used in the average circuit. This transistor was chosen only because it was available. Almost any n-p-n switching-type transistor may be used in this stage. During steady state, this transistor is fully saturated, and the *1N92* diode is therefore cut off. This prevents the 2,000-microfarad capacitor from charging. When a negative pulse is received from the multivibrator, the transistor goes from saturation to cut off, the diode conducts, and the capacitor starts to charge toward a voltage determined by the resistor divider consisting of the 15,000-ohm potentiometer and the 9,100-ohm 1% resistor in series with the 0-100 microammeter. This voltage is adjusted to one half the supply voltage so that the charging time constant is equal to the discharge time constant. After the multivibrator has returned to its original state, the transistor again saturates, cutting off the diode, and the capacitor starts to discharge through the 9,100-ohm resistor in series with the microammeter. Because of this series resistance, the meter is effectively a 0-1 volt, 10,000-ohms-per-volt voltmeter. The time constant of this circuit is about 20 seconds, which gives a good damping of the meter; however, it takes about 38 seconds to obtain a full-scale deflection of the meter with a repetition rate of 100 beats per minute. When the fast read or reset switch is closed, the two 4,700-ohm resistors are shunted across the potentiometer and series meter resistance. The time constant is reduced by a factor of three. The meter, therefore, will respond three times as fast, but the fluctuations will be too severe to tolerate. Therefore, this switch is only used to obtain the approximate pulse rate under emergency conditions.

The fast read switch is a double-pole single-throw normally open pushbutton switch and is intended for obtaining a faster rise from start on the meter, or for resetting the meter. Since a reading of 100 microamperes corresponds to a voltage across the capacitor of 1 volt, the capacitor will only charge up to 22% of full charge. This falls within the linear portion of the time constant curve (Fig. 6); thus, the necessity of recalibrating the meter was avoided, giving the monitor an over-all accu-

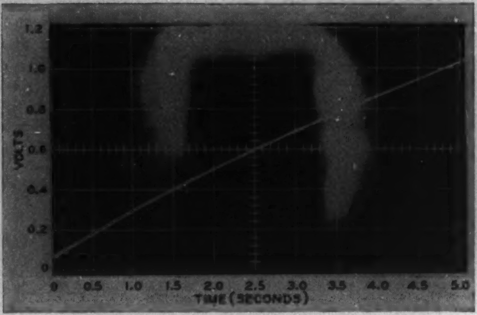

Fig. 6. Charging curve of 2,000 μf capacitor.

racy of better than 5%. The outstanding feature of this circuit is that by providing sufficient base current, the operation of the meter is almost entirely independent of the characteristics of the transistor used.

In the click position, the power amplifier is fed from the differentiating network consisting of the 100-microfarad capacitor and the 5,000-ohm volume control. The *1N92* diode serves to block the positive spike which occurs at the end of the pulse coming from the multivibrator. The 50,000-ohm resistor in series with this network prevents loading down of the multivibrator.

The power amplifier is a conventional *RC*-coupled amplifier utilizing a Texas Instruments Corporation *2N185* transistor. Transformer ratings again dictated the operating points of this circuit. The 47-ohm resistor in series with the emitter provides a degree of negative feedback and serves to protect both the transistor and output transformer from overload due to a sudden accidental increase in sound level. The input impedance is also raised because of this resistor, and the circuit is less likely to load down the transformer driving it. Plugging in earphones takes the output transformer out of the circuit and substitutes a 2,000-ohm load for a 600-ohm load. This does not affect the performance of the circuit.

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Development of Switching Tubes for Controlled Fusion Research

D. B. CUMMINGS

Conventional ignitrons have required extensive improvements to increase their current and voltage ratings to the high values required for controlled nuclear fusion research. A 4-year program to develop these improved tubes and the results achieved are described.

FOR OVER SEVEN YEARS the Lawrence Radiation Laboratory has conducted basic research toward the goal of obtaining power from the controlled fusion reaction. The ignitron tubes that have been developed for switching capacitor banks in the Mirror Machine (Pyrotron) and Pinch programs of research in controlled fusion at Livermore, Calif., will be discussed here.

The physics problem of obtaining power from a controlled fusion reaction is basically one of creating a magnetic bottle of 20 to 200 kilogauss, filling it with a plasma of highly ionized deuterium and/or tritium gas, heating the plasma to a kinetic temperature of over 100 million K (degrees Kelvin) and containing and/or compressing the plasma long enough for a useful reaction.[1] A temperature of 100 million K sounds quite unattainable, but in more familiar terms this means ions accelerated to an average energy level of about 9,000 electron volts, or 9 kev. Mirror Machines have coils which create the "magnetic bottle" with magnetic mirrors at the ends for particle confinement. These air-core solenoids are pulsed from a capacity bank to heat and compress an injected plasma. Pinch experiments rely upon the magnetic field created by the current carried by a plasma to compress or pinch the plasma.

A special article recommended by the Electron Tubes Subcommittee of the AIEE Electronics Committee.

D. B. Cummings is with the University of California, Berkeley, Calif., and is consultant to the Lawrence Radiation Laboratory, University of California, Livermore, Calif.

The author wishes to acknowledge the contributions of E. C. Hartwig, H. W. Van Ness, L. C. Ducote, C. C. McCombs, and W. Graves. This work was performed under the auspices of the U. S. Atomic Energy Commission.

CIRCUITS

The circuits for the capacitor banks used in both the Mirror Machine and Pinch programs are shown in Fig. 1. Fig. 1(A) shows the complex type of circuit with many series and parallel components typical of large, fast capacitor banks. Fig. 1(B) shows a simplified circuit. It is essentially a big very-high-power low-frequency tank circuit with a shunt diode. In industrial control literature it has been known as a "free-wheeling" circuit. However, in controlled fusion research the shunt tube is almost universally called a "crowbar." This is because of its similarity to the "crowbar" or "fault-diverter" circuit used to protect high-power oscillator tubes.

The actual waveshapes of a capacitor bank are shown in Fig. 2. The capacitor bank is charged up slowly from a high-voltage power supply and then discharged into the inductive load. The current rises sinusoidally for ¼ cycle. As the capacitor bank voltage starts to go negative, the shunt (crowbar) tube is fired. This permits the current to continue circulating through the coils with a decay time set by the circuit L/R ratio. However, the energy stored in the stray inductance of the capacitor bank and leads keeps the series tube from extinguishing. The capacitor oscillates through the shunt (crowbar) tube for a few cycles, modulating the shunt (crowbar) current. The effect on the load current depends upon the ratio of stray to load inductance and the amount of damping (resistance). It is comparatively large in the example shown, which is a 10-kv test bank.

Switching components have been required for many different types of capacitor banks, both slow and fast, Fig. 3 shows part of a typical fast capacitor bank, the 1-megajoule "Green River" (gamma pinch and collapse bank). Each of the 600 7.5-μf 20-kv capacitors, with its series tube and a shunt (crowbar) tube, is connected to the load with several parallel strands of *RG-8/U* coaxial cable. At this laboratory, 52-ohm cable is color-coded green, hence the name. A requirement for this bank might call for operating at 40 kv to achieve 10-megampere peak current. The Zeus bank at the Los Alamos Scientific Laboratory now has 6 megajoules. The partially completed Squash Court bank at Livermore has capacitors rated at 10 megajoules. If released rapidly, this energy would be equivalent to 5 pounds of high explosive. Banks have been planned with intermittent peak powers as high as 10^{12} watts. This is approximately seven times the installed electric generating capacity of the United States.

As capacitor banks became faster and potentially more destructive, higher performance and more reliability were required. It was necessary to learn how much abuse components could take, in order to improve them or to invent new ones.

SWITCHING-COMPONENT DEVELOPMENT

Alternative Approaches. There are at least three principal types of switching components which may be used to discharge capacitor banks. These are spark gaps, mechanical switches, and ignitrons. Spark gaps are especially useful for high voltages (20 to 100 kv) and short pulses ($<$10 microseconds) of very large currents (up to 5 megamperes). But they have a limited voltage range and have difficulties when used for long pulses. Mechanical switches have been used successfully on slower capacitor banks ($>$2 milliseconds) where currents are more modest ($<$30 kiloamperes). Ignitrons can be used successfully over a wide range of time scales (2 microseconds to 10 milliseconds) and currents (up to 150 kiloamperes for the shorter times). They can be used at any voltage up to about 15 kv (some higher) without adjustment, are readily available at relatively low prices, and can be fired easily. Lives of well over 10,000 operations without maintenance can now be expected.

For nearly 4 years, a program for switching-component development has been carried on at the Lawrence

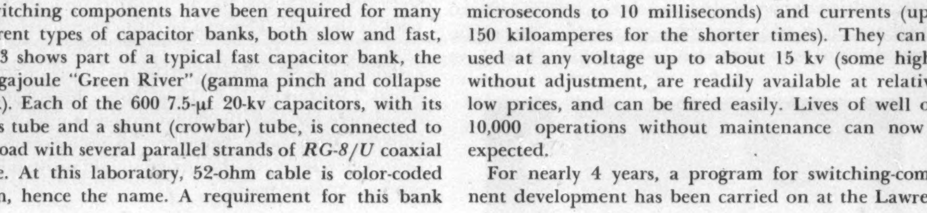

Fig. 1. Circuit diagrams of typical shunted (crowbarred) capacitor banks. (A) Complex bank with multiple components. (B) Simple bank used for small ignitron tests.

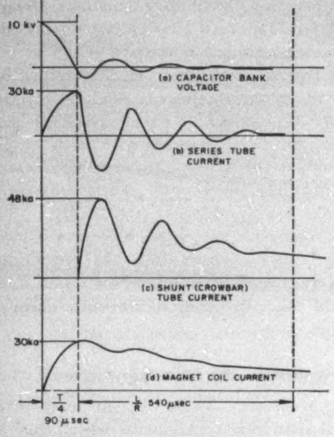

Fig. 2. Observed waveshapes for 10-kv small-ignitron test bank.

Radiation Laboratory in Livermore. For the aforementioned reasons, this program has largely been devoted to ignitrons. In co-operation with each of the three United States ignitron manufacturers, this laboratory has participated in the development of 5-inch ignitrons, an insulated-cathode 4-inch ignitron, 2-inch ignitrons, and a radical low-inductance flat ignitron. This laboratory also has tested switch tubes developed for other laboratories.

In addition, a mechanical switch has been developed to relieve shunt (crowbar) tubes, to combine the advantages of electronic and mechanical switching. Tests have also been performed on thyratrons, liquid-metal mechanical switches, and magnetic-force switches. Work has even been done on designing a very fast mechanical switch using the techniques of explosive metal forming. Semiconductors have been considered, but as yet it appears that the applications are substantially beyond the state of the art.

Fig. 3. Section of "Green River" bank (gamma pinch and collapse bank) of capacitors.

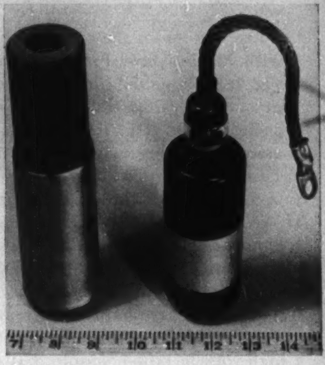

Fig. 4. Typical potted 2-inch switching ignitron (*left*) and *5550* welding ignitron (*right*).

Insulated Cathode Ignitron. Historically, the first tubes used at Livermore were the 5-inch-diameter type *5555* ignitron. These can carry up to 150,000 amperes for 50 to 100 microseconds. However, a limitation of steel ignitrons is that the arc transfers from the mercury pool to the wall. This can be quite destructive. To prevent this arc transfer, a 4-inch-diameter insulated-cathode tube was developed in co-operation with National Electronics, Inc. These tubes have each been tested here for over 10,000 low-voltage pulses at 10,000 amperes, each pulse being for 20 milliseconds. With further development, this design should prove useful for slower capacitor banks.

SMALL-IGNITRON PROGRAM

THE MAJOR EFFORT of the Livermore development program has been with small 2-inch tubes, shown in Fig. 4. On the right is the *5550* welding ignitron with which the work began. On the left is its descendant developed for switching applications. It has epoxy potting around the anode seal and an anode stud instead of a cable connection.

In co-operation with the General Electric Company, National Electronics, Inc., and the Westinghouse Electric Corporation, the most promising ideas were tried in sample lots and tested at Livermore in addition to tests by the manufacturer. The test was an arbitrary one using available components with an existing capacitor bank. The wave shapes are shown in Fig. 2. Tubes were tested in shunt (crowbar) service at 10 kv, which gave a life of 10 to 50 pulses on the first ones tried. Although a reliable 20-kv tube has always been the goal, long life at 10 kv was sought first. After the factors affecting life were determined and controlled, high voltage would then be stressed. It was expected that whatever was learned on 2-inch tubes would apply to the larger ones.

Design Variations and Results. Fig. 5(A) shows the cross section of a typical switch tube (dark areas). At first, anodes would fall off, thus necessitating an improved class of thread fit. Many tubes would not hold even 10 kv reliably. Various complex designs were tried with contouring and electrostatic shields in an attempt to achieve a better electrostatic field distribution. Results were poor. It was suspected that arc transfer to the wall liberated gas. Walls of molybdenum, graphite, and tantalum were tried. There was a large spread in the results. Other tubes were made with tantalum ignitor supports. These afforded only erratic success. In the meantime, other techniques began to give better results and the earlier approaches were discontinued.

Various processing schemes were tried on the assumption that failure was caused (or accelerated) by surface conditions or inadequate outgassing of metal parts. Stainless steel shells and vacuum-baked cathode parts were tried without clear-cut advantage. Longer exhaust cycles at higher temperatures seem advantageous. However, in one lot where this was maximized, the tubes were quite erratic because of mercury droplets which remained in the upper part of the tubes with unusual tenacity. A big improvement in the life of graphite anode tubes was obtained simply by the improvement of processing and better quality control. The greatest single improvement came from increasing the temperature at which the graphite anode is vacuum-baked from 1,800 C to about 2,400 C.

Gradually, tube life improved and the effects of prolonged operation on the cathode could be seen. Serious melting and deformation were seen on the ignitor support. This was attributed to mercury ion bombardment and was eliminated by moving the ignitor support out of the center of the tube.

After much effort, the typical life of a graphite anode tube was increased from 30 to many thousands of test pulses at 10 kv. Tubes have gone to over 10,000 pulses, but the average life is not known. Testing at 1 pulse per minute takes time and most tests are stopped at under 2,000 pulses. On early tubes, life was multiplied by 10 to 100 at 50% current. One might well expect a similarly increased life on improved designs with a similar derating.

With this success on 10-kv tubes, interest shifted to a new test capacitor bank for 20 kv and over. This bank has lower stray inductance and gives approximately the same current wave shapes as the 10-kv bank at twice the voltage. Series tubes are tested as well as shunt (crowbar) tubes. This test is more typical of actual usage in a fast capacitor bank.

Evidence accumulated that the weakest point in the tube was the throat where the anode seal joins the top or anode header. Arc tracking showed many breakdowns in this region. In order to improve electric field distribution, the design in Fig. 5(A) was tried. This "rounded-throat" design raised the operating voltage about 3 kv. Such tubes can be used up to about 17 kv, whereas the 10-kv-rated conventional tubes begin to fail above 14 kv. These voltages can be increased at lower currents.

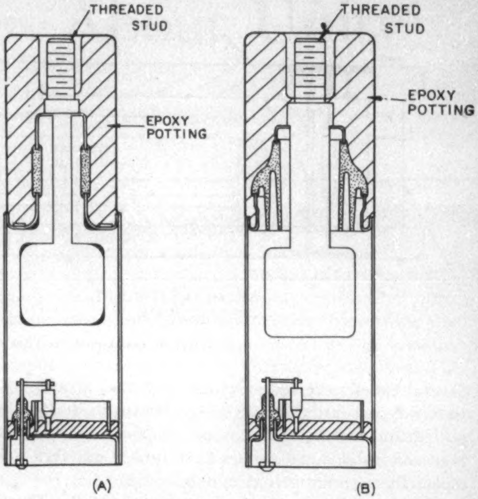

Fig. 5. (A) Experimental switching ignitron. Nonfilled line in throat and white area of anode show "rounded throat" tube with ¼-inch radii for improved electric field distribution. Black areas indicate contour of original switching tube. (B) Experimental "double-pantleg" switching ignitron. All-glass throat prevents breakdown there.

Improved processing increased tube life. Changing the electric field distribution gave a 17-kv tube; but a 20-kv tube was still wanted. A number of people had wondered if graphite were the best anode material.

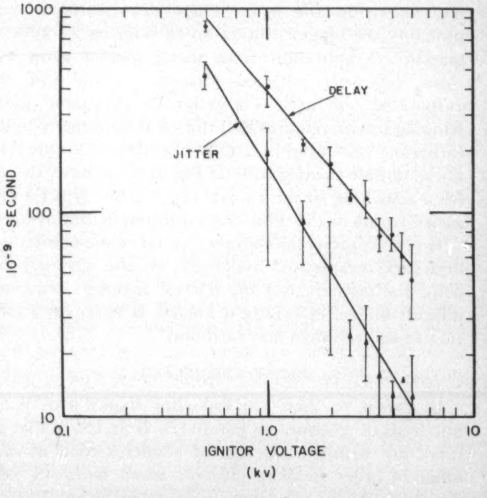

Fig. 6. Firing delay and jitter for best sample of three 2-inch switching ignitrons. Anode voltage, 5 kv. Dots indicate average of sample. Bars show spread of data from sample.

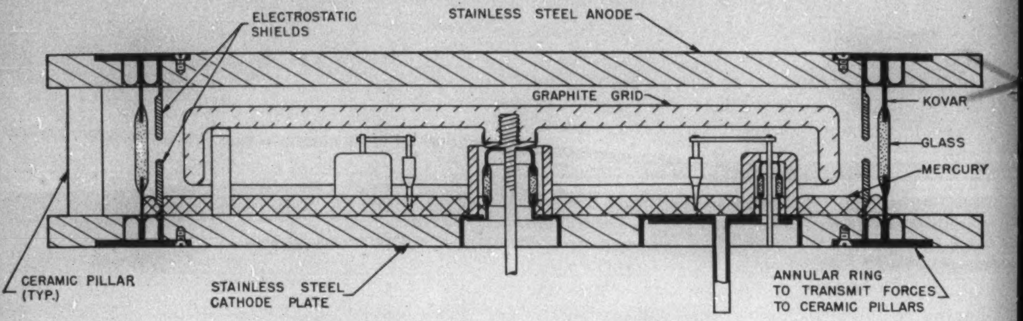

Fig. 7. Low-inductance, flat switching ignitron, 19-inch diameter.

Several tubes were tested which had steel anodes with titanium and tantalum orverlays. However, the overlay peeled and melted as the result of poor heat transfer. However, solid metal anodes have turned out very well, especially vacuum-melted molybdenum.

One successful design is shown in Fig. 5(B). This is the "double-pantleg" tube developed jointly by the Los Alamos Scientific Laboratory and General Electric. It appears good for at least 25 kv, although it showed no special promise with a graphite anode. The rounded-throat design showed a similar improvement with a vacuum-melted molybdenum anode. However, the double-pantleg tube appears able to pass higher currents because of better anode cooling, and performs better in ringing service (no shunt tube) because of the glass throat.

With such large currents, a portion of the anode surface is heated to the vaporization point during each pulse. With graphite anodes, a sooty coating was deposited within the tube. These dirty surfaces were probably the biggest limitation in holding 20 kv with graphite. Evaporation from metal anodes gives two clean, relatively polished surfaces. In addition, the evaporated film acts as a getter for unwanted gases. Ringing service requires that the arc reverse many times, each time restriking in a different place. Designs such as the double-pantleg tube in Fig. 5(B) prevent the arc from restriking in the throat, which is the poorest outgassed region of the tube. Gas evolution is thus avoided.

However, metal anode tubes, so far, have one serious drawback: evaporated metal gets on the ignitor. This helps the mercury wet the ignitor, making such tubes difficult to fire, especially if moved. It is hoped a solution to this problem may be found.

DELAY AND JITTER

In order to fire fast capacitor banks with many hundreds of ignitrons in parallel, it is necessary that all tubes fire within a fraction of a microsecond of each other in order to share current. Small ignitrons were tested for delay and reproducibility in firing. Fast coaxial circuits were used for both the ignitor and anode to achieve a rapid current rise and to permit precise time measurements. One batch of ignitors from one manufacturer was substantially faster, although this characteristic has not been controlled. Fig. 6 shows the results on a sample of three tubes from this batch. Note that it plots as approximately a straight line on logarithmic paper. These results agree with those predicted for a thermal mechanism of ignitor action.[2] With 5-kv ignitor voltage, the minimum average delay was 0.050 microsecond, and the minimum average jitter (total firing spread) was 0.012 microsecond. Other ignitors typically have values of delay and jitter three to four times larger. These data were taken with 5-kv anode voltage, but the results are not sensitive functions of anode voltage.

THE 19-INCH FLAT IGNITRON

It was desired to make a very fast capacitor bank with a rise to 30 million amperes in 2.5 microseconds. To achieve this, extremely low-inductance components were required. The proportions of a conventional ignitron are wrong for low inductance; they are long and narrow, whereas a short, flat ignitron is needed. The laboratory placed a contract with Westinghouse to make the radical, low-inductance flat ignitron shown in Fig. 7. This tube is 19 inches in diameter and 4 inches high. The grid was used to assure fast, reproducible firing and to hold higher voltage with a shorter grid-to-anode spacing. In addition, electrostatic shields were used to help hold voltage.

Inductance as low as 17 × 10^{-9} henry was measured at 22,000 amperes, with the inductance decreasing as the current was increased. The delay has been measured at 0.250 microscond with a jitter of 0.004 microsecond. The results have been promising enough to make it desirable to continue this work. It is hoped that this can be done using ceramics in a smaller size to achieve a practical low-inductance tube.

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Digest of Questions About Unity

T. M. LINVILLE
FELLOW AIEE

THE AIEE has proposed the Functional Plan as a step to develop sound organization for the engineering profession.

The Sections and Subsections have been asked by the Board of Directors to hold open membership meetings to discuss the Functional Plan. The objectives are to inform the AIEE membership about the Plan and to test it against the reactions and opinions of the membership.

A Task Force of 53 members, covering all areas of the nation, has been set up to assist the Sections and to participate in the meetings if needed. A Manual and other materials have been sent to all Sections and Subsections for guidance and help. Reports to the Board have been requested.

The questions raised in the meetings held to date, and by meeting planners, are presented here in digest form. This is essentially the same digest as was distributed by mail at the request of many of the Section and Subsection officers.

WHAT ARE THE "BUILDING BLOCKS" OF UNITY?

IT GOES ALMOST WITHOUT SAYING that a unity organization must be built compatible with the societies that already exist. It would be foolhardy in the extreme to try to do otherwise. Therefore, the existing societies and their council organizations are the building blocks of unity.

The societies now are autonomous, as they have been since their establishment. For co-ordinated activities and communication with one another, they have formed the Engineers Joint Council (EJC) and the Engineers' Council for Professional Development (ECPD). Each society, of course, is formed by individual engineers having a branch of engineering as their common interest. Activities, services, lectures, discussions, publications, etc., are carried on at the national, district, and local section levels.

In addition to the societies in each of the engineering branches, another national society, the National Society of Professional Engineers (NSPE) gathers together the engineers who have as their common interest a legal license to practice professional engineering. The purpose of legal licensing, established by all of the states and territories, is to provide a mechanism by which an engineer can be authorized to present himself to the public as such—an authorization in which the public can have confidence. Originally it was civil engineers with whom the public was most concerned, but public interest in all branches of engineering has developed more and more as time and technical progress has advanced.

Individual engineers belong to NSPE directly, and also to state and county societies of it. On all these levels, services, lectures, discussions, publications, and other activities focus attention on matters concerning the professional practice of engineering, its legal status, economics, regulation and the public interest in it. The membership of NSPE had broadened over the years. Electrical and mechanical engineers employed in industry, for example, have joined it, complementing the civil engineers, consulting engineers, and other engineers in civil employment who constituted so great a part of its early membership.

WHY DO WE WANT UNITY?

OBVIOUSLY, through EJC, ECPD, and NSPE, we are unified to a large extent. You might challenge anyone to mention a basic need for unity that is not already included in the charter of one or more of these organizations. Why, then, is there a demand for more unity.

On this question, I presume most engineers feel that three organizations are not as satisfactory as a single organization in serving the comprehensive needs of the engineering profession. For example, from a public relations point of view, is the engineering profession one thing or three? Which of the three, if any, is the real "headquarters" of the profession? Why, an interested layman might ask, doesn't the profession have one comprehensive body?

WHY NOT MERGE EJC, ECPD, AND NSPE?

UNDOUBTEDLY, to many engineers the obvious way to meet the need for a comprehensive body is to create it by establishing an organization with EJC, ECPD, and NSPE as its three elements. Let us consider some of the reasons why this is easier said than done.

A basic difficulty is that many engineers who can join the member societies of EJC and ECPD cannot join NSPE because they are not licensed. Obviously, we cannot create a unity body with one of its principal elements closed to many engineers. Moreover, in order to facilitate a merger, it is necessary to define the scope of action of each of the elements and to make it impossible for the parent body to trespass on the responsibilities and functions of any of its members. Unless this is done, the bodies cannot work together successfully. NSPE, for example, derives its authority from its members, and could not accept authority of the parent body with its broader membership over its internal affairs and functions. The same is true of AIEE. But the climate would

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T. M. Linville, Chairman of the Task Force, is with the General Electric Company.

be different, provided that its purposes and functions were not to be trespassed upon.

WHY NOT MERGE EJC AND ECPD EXCLUDING NSPE?

THE IDEA of merging EJC and ECPD has been presented by engineers who recognize that these two bodies have largely a common membership. Thus, why not merge them?

The problem here is that this does not answer the need for a comprehensive organization, because NSPE is left out. Suppose we go ahead without NSPE? The hard fact then is that to obtain a comprehensive organization, the purposes and functions of NSPE must be taken up. To do this means not only competing with NSPE but paying the price to compete, which—as measured by NSPE's financial resources—is over a million dollars a year! Furthermore, to compete effectively would require the equivalent organization structure active at the county and state levels, as well as the national level. It would thus seem to be indeed imprudent, if not impossible, to attempt to establish a new organization paralleling the NSPE organization. NSPE simply cannot be excluded from any scheme to establish a truly unified and comprehensive organization.

However, the question of why we should not merge EJC and ECPD persists simply because many view it as a step that can be taken. The answer is that since EJC and ECPD are each doing their jobs without conflict, nothing is to be gained by a merger. We had better let well enough alone. If the merger should tend to promote competition with NSPE, resulting in less unity than we now have, we would have taken a step backward. We must look for a better alternative.

WHAT IS THE FUNCTIONAL PLAN?

IN RESTLESSLY SEARCHING for the better alternative, the AIEE in 1956 conceived and proposed the Functional Plan. This Plan is very simple: it only proposes that the purposes and functions that should apply to EJC, ECPD, and NSPE, respectively, be clearly defined and untangled. It does this by classifying purposes and functions pertaining to each of three categories, namely, educational, technical, and professional. Educational functions are assigned to ECPD, technical to EJC, and professional to NSPE. Fortunately, the organizations naturally fit these categories, respectively. However, overlapping and entanglements that now exist would be eliminated and the focus of EJC's activities, especially, would be more sharply established.

WHAT DIFFERENCE WOULD ADOPTION OF THE FUNCTIONAL PLAN MAKE?

CONTRARY to the belief of many, adoption of the Functional Plan would change things in important ways. Although we will still have three organizations to serve the comprehensive needs of the profession, and they will have the same familiar names, there will be differences. For instance, each will play an exclusive part and, therefore, can work easily and harmoniously with the other two without the confusion of uncertain or unaccepted relationships. This is extremely important. Furthermore, it has far-reaching consequences for NSPE.

NSPE will be recognized and looked to by the whole profession as a body responsible for meeting comprehensive needs. When this occurs, it becomes appropriate (even necessary, from the point of view of many) for membership in NSPE to be made available to every *bona fide* engineer. Otherwise NSPE, while strictly acting in behalf of its own members, would in practical effect be acting for all engineers including those who could not be represented in its membership, which would be an injustice. The problem here is that many engineers are not registered and only registered engineers are admitted to NSPE. Of course, membership in NSPE would be available to all who wished to join through the procedure of becoming registered first. It might be fair enough to require that future graduates in engineering become registered. But to many persons it would not be fair to require that persons established in engineering work in responsible capacities become registered only to make it possible for them to join NSPE. Therefore, NSPE very likely will seek some method to avoid this "injustice."

I might hasten to repeat what I said earlier, i.e., that registration is the mechanism set up by the public to identify engineers as "professional engineers." Therefore, registration has to be the basis for membership in a professional society that is to be recognized as such by the public. For example, in New York State the members of the Legislature have expressed themselves freely that on engineering matters of public concern they recognize and listen to P.E.'s exclusively. From their point of view, they say, there aren't any other engineers in whom they feel they can place full confidence. It seems appropriate that membership in NSPE for unregistered engineers should be considered only with formal adoption of the Functional Plan by major technical societies and then only for graduate engineers of past years who occupy positions with important responsibilities for engineering work. In the course of a short time NSPE should return again to a membership of registered engineers exclusively.

Likewise, the major technical societies should consider establishing a "professional member" grade, requiring registration among the qualifications for admission. The American Society of Civil Engineers (ASCE) has already established an equivalent grade.

Another important change is that it would become clear to engineers that there is no escaping the fact that the cost of unity, for those who wish to support it, is the price of membership in a technical society plus NSPE. I believe adoption of the Functional Plan would make this clear.

Finally, the climate for close co-operation and co-ordination of EJC, ECPD, and NSPE would be established and these groups, working together, could make progress faster toward a single comprehensive organization. This body would not disturb the specialized, independent technical societies with respect to functions serving the special interests of their members.

WHAT IS THE VALUE OF INDEPENDENT TECHNICAL SOCIETIES–

THE OBVIOUS REASON for independent technical societies is the fact that those who have the most vital interest in advancing the art and science of electrical engineering are the "electricals." Likewise, the "mechanicals" in mechanical engineering, the "civils" in civil engineering, and so on. It is best that technical responsibility in each discipline be carried independently. History has shown clearly that "splinter" societies have been bound to develop wherever there has been sufficient focus of separate interest. They would surely redevelop if we tried to over-consolidate technical interests.

Another powerful argument for independent technical societies is that the internal revenue laws classify any comprehensive professional society with "trade associations," NSPE has such a classification; the technical societies are, and always have been, classified as "scientific and educational associations." Both groups are exempt from income tax but only the latter is exempt from real estate tax and entitled to receive gifts that are tax deductible by the donor. The difference is illustrated by the case of the United Engineering Center which is being constructed in New York City. The technical societies are raising over 9 million dollars through gifts that are tax deductible by the donors only because of the classification of the societies. No "trade associations" can be housed in the building. If the classification of these societies should be changed they would be subject to real estate taxes, and it has been estimated that as much as a $5 dues increase per member would be needed to pay the extra costs. Raising of funds by contributions in the future would be very difficult. There is no need for this, as the societies are truly "educational and scientific" organizations.

In the medical and legal professions, AMA and ABA, respectively, are classed with "trade associations," like NSPE, for tax purposes. Both of these professions have numerous specialized societies classified as "scientific and educational associations" like our technical societies. To retain their classification, the technical societies cannot be associated in any substantial way with NSPE or with the NSPE purposes and functions. However, their individual members can through dual memberships. Should a majority of individual members establish dual memberships, then the membership body of a technical society would also be present within NSPE.

WHAT IS THE AMALGAMATION PROPOSAL?

AN ALTERNATIVE PROPOSAL to the Functional Plan, which has been under discussion in EJC and which has been referred to the Boards of the constituent societies, is known as the "Amalgamation Proposal." As I understand it, this calls for the EJC corporation to take over ECPD (amalgamation of ECPD and EJC) and then to form three divisions of the enlarged corporation; an educational division (to be ECPD), a technical division, and a professional division. Provided NSPE becomes one of the constituent societies of the corporation, it may be delegated the responsibilities in the professional division.

The problem here is that NSPE is to be asked to join on the same basis as AIEE and the other societies. But when it becomes a member, it is to be responsible for the professional division paralleling the educational and technical divisions. Thus, we are right back to the difficulties already mentioned in regard to the question: "Why not merge EJC, ECPD, and NSPE?" Moreover, the proposed corporation will surely be considered a "trade association" because of the professional division. At least two major technical societies have been advised by legal counsel that their preferred status would be in jeopardy.

Because of such problems, the Amalgamation Proposal has not gotten off the ground, and has been, frankly, unacceptable to AIEE. It has not been presented to NSPE, but one would expect it to be unacceptable here as well. Therefore, it does not appear to be a road to unity.

WHAT ABOUT A CO-ORDINATING COUNCIL FORMED BY EJC, NSPE, AND ECPD?

THE FUNCTIONAL PLAN has been criticized by some as not being a unity plan. Actually, it proposes three independent organizations, one each in educational, technical, and professional activities. The first two are expected to be "educational or scientific" associations and the third to be classified with professional groups ("trade associations"). Obviously, this does not achieve the ultimate goal of a single comprehensive engineering association. So it has been suggested that a council should be formed with the three bodies as its elements.

In order to have the parent organization really be a single comprehensive professional organization, it should be a corporation exercising authority over its divisions, directing operations and expenses.

This proposal is confronted with the same problems as have been described for the proposed corporate body of the Amalgamation Proposal, i.e., if it is a formal organization, it no doubt would be classed as a "trade association" and so would its constituents. Furthermore, in considering acceptance of the proposal, participation by NSPE would be blocked by the problems already described.

HOW THEN DO WE GET OUT OF THIS DILEMMA?

THERE SEEMS to be frustration at every turn, presenting a real dilemma. But get out of it we must, and a way has been suggested that AIEE has stated is acceptable and not inconsistent with the Functional Plan.

This suggestion is for EJC, ECPD, and NSPE to form an *informal* council for co-ordination which will have no operating activity and no directing authority over its members. Its functions would be, for example, to exchange information, encourage studies (especially for further progress toward unity), and arrive at voluntary agreements in jurisdictional questions. Its activity would be exclusively self-educational. It might have a name, an

REPORT FORM

Section Meeting Date: Reported By: Date:

PLAN		AIEE Functional Plan	Amalgamation Plan	Other Plan	Status Quo	Not Voting	Total
TOTAL VOTE	No.						
	%						
OPEN BALLOT Balloting--According to Society Affiliation: (Some of those present will be members of more than one society and their vote will be tabulated more than once here.)	AIEE						
	NSPE						
	IRE						
	ASEE						
	ASME						
	ASCE						
	AIME						
	AIChE						

Section Meeting Date: Reported By: Date:

PLAN		AIEE Functional Plan	Amalgamation Plan	Other Plan	Status Quo	Not Voting	Total
TOTAL VOTE	No.						
	%						
RESTRICTED BALLOT* Balloting--According to Society Affiliation: (Some of those present will be members of more than one society and their vote will be tabulated more than once here.)	AIEE						
	NSPE						
	IRE						
	ASEE						
	ASME						
	ASCE						
	AIME						
	AIChE						

COMMENTS:

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*Restricted to choice between AIEE Functional Plan and Amalgamation Plan only.

office address, and a secretary. It would be a consulting body rather than an operating body.

The suggestion would appear to be a good one.

WHAT ELSE IS GOING ON IN INTERSOCIETY DISCUSSIONS?

FOR SEVERAL YEARS, since the proposal of the Functional Plan, there has been a continuing Task Force on Unity comprised of five Presidents (some have become recent ex-presidents) of the Founder Societies. Their discussions have been frustrating too, and they very recently disbanded. However, they unanimously agreed on a final proposal to each of the societies, i.e., they propose that the presidents and senior vice-presidents of EJC, ECPD, and NSPE meet regularly four times a year for discussions. They recommended that each society endorse this and implement it through their representatives to EJC and ECPD. They also sent the proposal to the presidents of EJC, ECPD, and NSPE. It seems reasonable that this suggestion will receive prompt acceptance.

Various other meetings have been held frequently by intersociety relations committees of the founder societies and NSPE, separately and jointly, giving promise that some positive forward action will be taken soon.

NSPE conducted a survey of its membership opinion on the Functional Plan which also afforded substantial numbers of members of AIEE, ASME (American Society of Mechanical Engineers), and ASCE within NSPE, the opportunity to express themselves. The results have been published by NSPE and have created wider and deeper interest in the Functional Plan, which the survey results strongly supported.

HOW HAS THE FUNCTIONAL PLAN BEEN RECEIVED?

ASME and NSPE have endorsed the AIEE Functional Plan in principle. Thus, three major societies are favorable to it. ASCE, probably because of independent interest in professional matters of vital concern to their members—so many of whom are in public or civic practice, has been cold towards it. However, the Functional Plan would not in any way interfere with this interest. AIME (American Institute of Mining, Metallurgical and Petroleum Engineers) and AIChE (American Institute of Chemical Engineers), because registration is not prevalent among their members, and not generally available to mining engineers, have recognized problems for them with respect to it which need consideration.

SHOULD ENGINEERS JOIN TWO SOCIETIES?

The problems encountered in the search for a single comprehensive engineering organization suggest the possibility of a future time when the majority of full members of the technical societies would be members of NSPE and, likewise, the majority of NSPE members would be members of the technical societies. In such a case, then, independence of the technical societies would continue and unity would be achieved through the gathering together of individual engineers in a professional body.

With respect to this possibility, two important factors need to be recognized. First, registered engineers can bring this about now, if they choose, by joining NSPE in addition to their technical society. Thus, these engineers individually can have unity by voluntary individual action if they want it. Secondly, nonregistered engineers, particularly those in the member-grade in the technical societies (or qualified for it) can have this unity also if NSPE membership is made available to them. If this should be done, then to have or not to have unity could be put up to engineers individually on a profession-wide basis. In view of the importance of registration already mentioned, presumably such a grade of membership should be made available only to a present group of engineers whose qualifications would be clearly defined.

WHAT CAN BE DONE NOW?

AIEE membership opinion will have an impact on the leaders of all societies. Even more importantly, it will have an impact on the grass-roots membership opinion of other societies, especially if Section meetings are held jointly with other societies with open discussion. Moreover, joint meetings tend to bring more detailed information to a greater number of members. A reflection of informed membership opinion is needed.

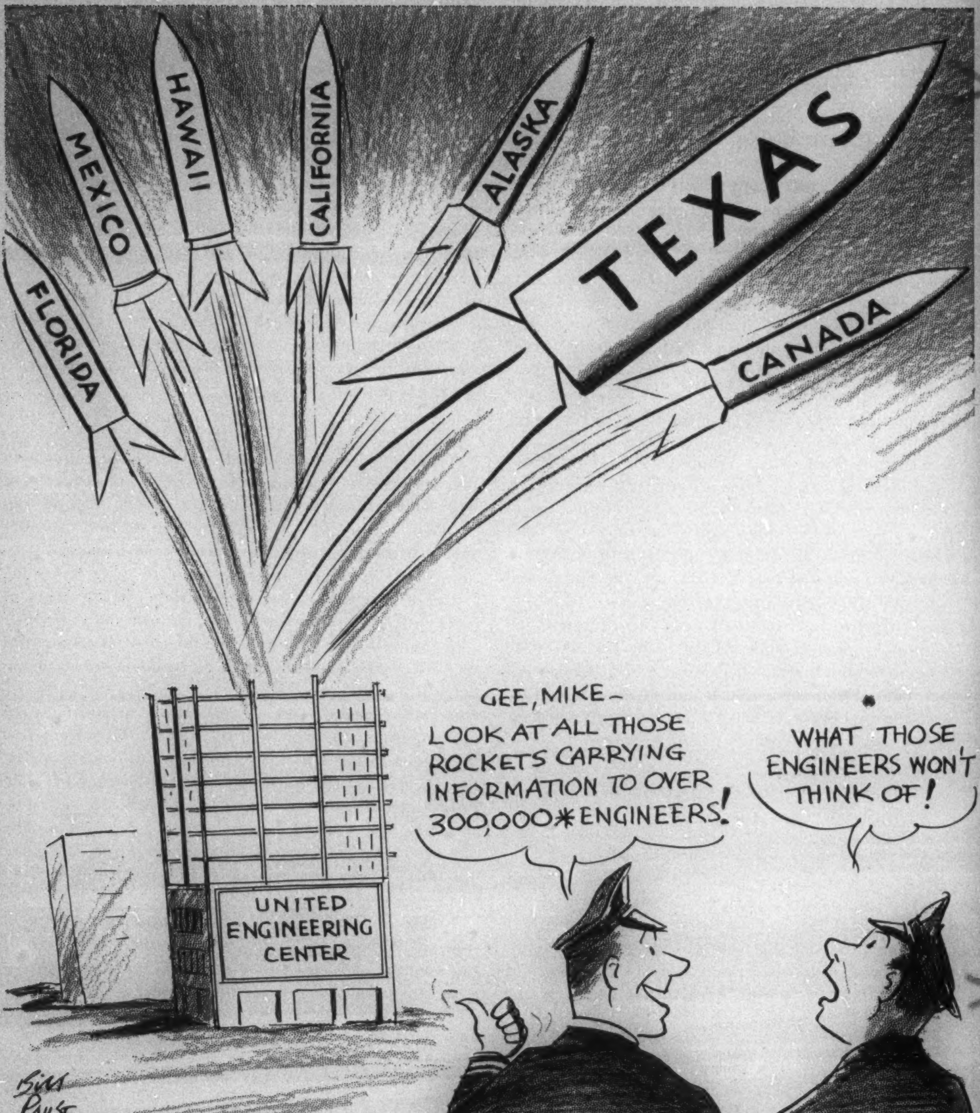
To obtain such opinion, the Board of Directors has requested each Section and Subsection to hold a membership meeting on Unity, together with other societies wherever feasible, and to poll those attending each meeting on the questions illustrated on the accompanying report form. This form shows the information that the Directors want reported to Mr. Hibshman. The Board asks that the reports to sent to Mr. Hibshman by December 31, 1960, if possible, so that a report can be prepared for the Board of Directors meeting in February 1961. The results will be published promptly then in *Electrical Engineering*.

This is the most important contribution AIEE Section and Subsection Officers and members can make at this time, i.e., to hold and attend such meetings, participate in discussions, and submit ballots.

Detectors for Radiation Measurement

Four radiation detectors, developed by a team of nuclear physicists at the Hughes Aircraft Company, Culver City, Calif., have been delivered to the U. S. Air Force School of Aviation Medicine, Aerospace Medical Center, San Antonio, Tex., for an experiment to measure the amount of radiation man will meet in space. Packaged with signal amplification units in small, cigar-size cylinders, the detectors will be carried in simulated space-crew cabins in high-altitude balloon ascents and in Atlas intercontinental ballistic missile space flights. The main purpose of the experiments will be to measure the amount of radiation penetrating the cabins.

The detector is essentially a thin slice of silicon. When struck by charged nuclear particles, it emits pulses which are fed to a telemeter system inside the space vehicle by the detector package's amplifier. The telemeter system transmits the signals to receiving stations on earth as the vehicle moves through space.


FLORIDA
MEXICO
HAWAII
CALIFORNIA
ALASKA
TEXAS
CANADA
UNITED ENGINEERING CENTER
GEE, MIKE– LOOK AT ALL THOSE ROCKETS CARRYING INFORMATION TO OVER 300,000* ENGINEERS!
WHAT THOSE ENGINEERS WON'T THINK OF!
BILL PAUSE

***WHEN COMPLETED IN 1961,** the new United Engineering Center will serve over 300,000 society members and students throughout the free world in contrast with 16,000 members when the old headquarters was built in 1906. The layout also provides for future expansion.

No matter how young you may be or where you may live, the United Engineering Center will bring you a lifetime of benefits.

The AIEE has 94% of its quota, but we must have additional help NOW to complete our share—Let's finish the job!

INSTITUTE ACTIVITIES

Nominating Process Has Begun for 1961 Election of AIEE Officers

FOR the nomination of officers to be voted upon in the Spring of 1961, the AIEE Nominating Committee will meet in New York, N. Y., January 30, 1961. The officers to be elected are: a President, a Treasurer, two Directors-at-Large, seven District Vice-Presidents, one from each of the even-numbered geographical Districts, three Technical Vice-Presidents, and two Department Directors. Fellows only are eligible for the office of President; Members and Fellows for the offices of Vice-Presidents, Directors, and Treasurer;

To guide this committee in performing its constituted task, suggestions from the membership are, of course, highly desirable. To be available for consideration of the committee, all suggestions must be received by the Secretary of the committee at Institute headquarters, not later than December 15, 1960.

In accordance with the provisions in the Constitution and Bylaws, quoted in the following paragraphs, actions relating to the organization of the Nominating Committee are now under way:

Constitution and Bylaws Pertaining To Elections

C60.010. Nominating Committee. The Nominating Committee is composed of voting members, as defined in C20.110, selected by and representing parts of the Institute as follows:

C60.011. Districts have one representative each.

C60.012. Technical Divisions have one representative each.

C60.013. Board of Directors has representatives not exceeding the number of the Technical Divisions.

C60.014. Secretary. The Executive Secretary of the Institute acts as Secretary of the Nominating Committee, without vote.

C60.020. Nominations. The Nominating Committee meets and nominates candidates for Institute office according to instructions contained in the Bylaws. The committee names one candidate for each vacancy in the office of President, Treasurer, and Directors-at-Large. It includes in its slate such candidates for (a) Vice-Presidents as have been nominated by the Executive Committees of the Districts concerned, (b) Vice-Presidents as have been nominated by the Technical Divisions concerned, and (c) Directors as have been nominated by the Departments concerned. If a District, Division, or Department fails to nominate a candidate for Vice-President or Director, the Nominating Committee nominates a candidate from the unit concerned. Additional nominations for any office may be made by written petition of 25 or more voting members, in accordance with rules set forth in the Bylaws. For the office of District Vice-President, the petitioners must be from the Districts concerned.

C60.021 Candidates for any office must hold a grade of membership which entitles them to serve if elected.

B60.011 District Members of Nominating Committee. Each District has one representative on the Nominating Committee. During September of each year, the Secretary of the Nominating Committee shall notify the Chairman and Secretary of the Executive Committee of each District that, by December 15 of that year, each District should select a representative to serve as a member of the AIEE Nominating Committee, and an alternate to serve if the representative is unable to attend the meeting of the Nominating Committee.

B60.012 Technical Division Members of Nominating Committee. During September of each year, the Secretary of the Nominating Committee shall notify the Chairman and Secretary of each Technical Division that, by December 15 of that year, each Technical Division should select a representative to serve as a member of the AIEE Nominating Committee, and an alternate to serve if the representative is unable to attend the meeting of the Nominating Committee.

B60.014 Secretary of Nominating Committee is as defined in C60.014.

B60-020 Procedure for Nominations. The Secretary of the Nominating Committee shall give the members not less than 10 days' notice of the first meeting of the Committee, which shall be held not later than February 15. At this meeting, the Committee shall elect a Chairman and shall proceed to make up a ticket of Nominees for the offices to be filled at the next election.

During September of each year, the Secretary of the Nominating Committee shall notify the following groups that nominations, as designated, should be received by the Secretary of the Nominating Committee by December 15th of that year.

a. The Chairman and Secretary of the Executive Committee of each District, in which there will be during the year a vacancy in the office of District Vice-President, a nomination for a District Vice-President, made by the District Executive Committee;

b. The Chairman and Secretary of each Technical Division, in which there will be during the year a vacancy in the office of Technical Vice-President, a nomination for a Technical Vice-President, made by the Technical Division Committee;

c. The Chairman and Secretary of each Department, in which there will be during the year a vacancy in the office of Department Director, a nomination for Department Director made by the Department.

B60.022 Independent Nominations. Additional nominations for any office may be made in accordance with C60.020. Petitions, proposing the names of candidates as independent nominations for the various offices to be filled at the ensuing election, in accordance with C20.020, shall be received by the Executive Secretary not later than March 15 of each year. These nominations shall be included on the ballot if such candidates are eligible.

B60.030 Ballots. On or before April 15 of each year, the Executive Secretary shall mail to all qualified voters an official ballot on which are to be listed all eligible candidates, nominated as provided in C60.020. The candidates of the Nominating Committee shall be appropriately designated as such. Any nominee may, prior to the printing of the ballots, withdraw his name by written request to the Executive Secretary, whereupon that fact shall be suitably indicated upon the ballot.

In the event of no contest for any office, the slate of the Nominating Committee, in the form of a ballot, and having a reference to the biographies of the candidates in *Electrical Engineering*, shall be mailed to the voting members.

B60.031 Methods for Balloting. The voting for each office shall be restricted to the nominees for that office as printed on the ballot. When there is a contest for any office, the ballot shall be accompanied by an envelope on which shall be printed the title of the Institute, the name and address of the Executive Secretary, and the words, "Official Voting Envelope—Enclosing a Ballot Only." The names of the nominees shall be written, printed, or otherwise marked on a single ticket or ballot, which shall be enclosed in a sealed unmarked, and unidentified inner envelope of any suitable character, which shall in turn be enclosed either in the "Official Voting Envelope" (received from the Executive Secretary), or any other envelope, marked on its face, "Non-Official Voting Envelope—Enclosing a Ballot Only." The outer envelope of either class shall be identified by the name of the sender, shall be sealed, and in order to be counted, shall reach the Executive Secretary not later than the first day of June.

B60.040 Tellers Committee Appointment. The President, during the month of May, shall appoint, subject to the approval of the Board of Directors, a Tellers Committee. This Committee shall be selected from voting members. Members of the Board of Directors, members of the Nominating Committee or their alternates, or any nominee appearing on the ballot, or petitioners of a nominee, are ineligible to act as tellers. Other appointees as tellers are authorized by written petition delivered to the Executive Secretary on or before the first day of May. A minimum of 20 signatures of voting members is required. A petitioner is eligible to sign only one petition. Each signer shall have the qualifications of a teller.

B60.041 Tellers Committee Report. The Tellers Committee shall meet at the office of the Institute as soon after the first day of June as possible and prepare an Election Report; one copy filed with the Executive Secretary, the other copy with the Chairman of the Tellers Committee and kept sealed until presented to the presiding officer of the ensuing Annual Meeting. In the absence of the Chairman of the Committee, the Executive Secretary will present his copy to the Election Report. The Tellers' Election Report shall give the sum total of the ballots received, and shall designate this total as a vote for the entire slate of officers where there are no alternative candidates. Only in the case of a contest shall an individual count be made. The presiding officer at the Annual Meeting shall cause the report to be read, and shall declare those duly elected in accordance with the results of the vote as presented in the report.

(Signed) N. S. Hibshman
Executive Secretary

Symposium *Proceedings* Are Available for Shipment

Once again, *Proceedings* of all six National Symposia on Reliability and Quality Control are in stock for prompt shipment.

Within the last year, stocks of four of these—1st, 2nd, 3rd, and 5th—were depleted. These four have now been reprinted and are in stock for the filling of orders.

Orders for desired volumes, at $5 net each volume postpaid, should be sent to the Editorial Department, Institute of Radio Engineers, 1 E. 79th St., New York 21, N. Y.

AIEE is one of four constituent organizations which sponsor the symposium.

Nominees Sought for Five AIEE Awards

THE Recognition Awards Committee of the AIEE is seeking nominees for five AIEE awards, in the fields of:

Electrical Engineering Education
Transmission and Distribution
Telecommunication
Electrical Measurement
Electronics

These awards will be made October 15-20, 1961, at the Fall General Meeting in Detroit, Mich.

All members of the Institute are eligible to submit nominees. Such nominations are to be made on a form which may be procured from the Secretary of the Recognition Awards Committee, at AIEE Headquarters, 33 W. 39th St., New York 18, N. Y. Each form should be accompanied by supporting letters from others who are familiar with the accomplishments and qualifications of the nominee. These forms and letters are due at Headquarters not later than April 1, 1961.

Descriptions of the five awards follow.

The **MEDAL IN ELECTRICAL ENGINEERING EDUCATION** provided for by the Members-for-Life Fund Committee will be given to a teacher of electrical engineering selected for his excellence in teaching and his ability to inspire students to higher achievements; for his contributions to the teaching of electrical engineering through text books and by writings on engineering education; for his active participation in the work of the professional and educational societies; and for his contributions to teaching and the profession through research, engineering achievements, and technical papers.

The award consists of a cash stipend of $500, a bronze medal, and a suitably engraved certificate.

All previous nominations received in connection with the award of this medal must be renominated by letter to Institute Headquarters. Supplementary information on these past nominees may, of course, be forwarded with the renomination for attachment to the present file.

Awards of the medal have been as follows:

1956—F. E. Terman
1957—W. L. Everitt
1958—J. F. Calvert
1959—G. S. Brown
1960—Ernst Weber

The **WILLIAM MARTIN HABIRSHAW AWARD** established by the Phelps Dodge Foundation will be made annually to an individual or group of individuals who have made an outstanding contribution to the field of Electrical Transmission and Distribution.

Mr. Habirshaw was a chemist who pioneered in the first a-c high-voltage underground cables used in America. He designed the 11,000-volt underground cable system of the Cataract Power & Conduit Company which was installed at Buffalo, N. Y., in 1898 and 1899, and gave very satisfactory service for many years. Mr. Habirshaw was one of the founders of the American Chemical Society.

The award consists of a cash stipend of $500, a bronze medal, and a suitably engraved certificate. In the event that the recipient is a group of individuals, the stipend shall be equally divided among the members of the group and a medal and a certificate provided for each.

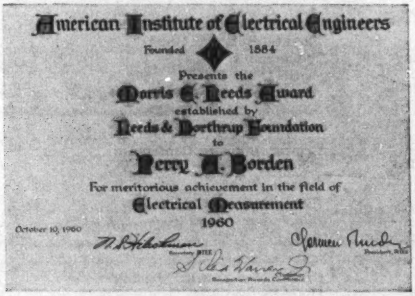
Awards of the medal have been as follows:

1959—W. A. Del Mar
1960—S. B. Crary

The MERVIN J. KELLY AWARD established by the Bell Telephone Laboratories, Inc., will be presented annually in the field of Telecommunication.

The award consists of a cash stipend of $1,000, a bronze medal, and a suitably engraved certificate. In the event that the recipient is a group of individuals, a separate award may be made to each of them in a single year provided that the Institute shall withhold making the award for a number of immediately ensuing years equal to the awards in excess of one so made in a single year.

The first award was made to Dr. Mervin J. Kelly in 1960.



American Institute of Electrical Engineers
Founded 1884
Presents the
Morris E. Leeds Award
established by
Leeds & Northrup Foundation
to
Perry A. Borden
For meritorious achievement in the field of
Electrical Measurement
1960

October 10, 1960

Secretary, AIEE

President, AIEE

Morris E. Leeds

The MORRIS E. LEEDS AWARD established by the Leeds & Northrup Foundation will be presented annually to an individual or group of individuals who have benefited the arts and sciences by making an outstanding contribution to the field of Electrical Measurement, with special consideration given to the value of contributions made before the candidate has reached his 36th birthday.

The award consists of $500 and a suitably engraved certificate. In the event that the recipient is a group of individuals, the stipend shall be equally divided among the members of the group, and a certificate provided for each.

Awards of the medal have been as follows:

1959—H. B. Brooks
1960—P. A. Borden

The DAVID SARNOFF AWARD established by the Radio Corporation of America will be given annually in the field of Electronics.

The award consists of a 14-carat gold medal, a bronze replica, and a suitably engraved certificate. Preference is given to achievement by a single individual, but if in the opinion of the Institute's Committee the award should be conferred upon a group of individuals who have functioned as a team, the award may be conferred upon such individuals up to three in number. Each member of such a team will receive a gold medal, a bronze replica, and a certificate.

Awards of the medal have been as follows:

1959—David Sarnoff
1960—Rudolf Kompfner

AIEE Future Meetings

AIEE-IRE-ISA Electrical Techniques in Medicine and Biology Conference*
Sheraton Park Hotel
Washington, D. C.
October 31—November 2, 1960

Western Appliance Technical Conference*
Biltmore Hotel
Los Angeles, Calif.
November 7, 1960

Power Industry Computer Application Conference*
Chase Hotel
St. Louis, Mo.
November 9-11, 1960

Fall Textile Conference*
Sir Walter Hotel
Raleigh, N. C.
November 10-11, 1960

AIEE-AIP Magnetism and Magnetic Materials Conference*
Hotel New Yorker
New York, N. Y.
November 14-17, 1960

AIEE-NEMA Application of Electrical Insulation Conference*
Conrad Hilton Hotel
Chicago, Ill.
December 5-8, 1960

AIEE-IRE-ACM Eastern Joint Computer Conference*
Hotel New Yorker
New York, N. Y.
December 11-14, 1960

AIEE-IRE-ASQC-EIA Reliability & Quality Control Conference
Bellevue-Stratford Hotel
January 9-11, 1961
(Final date for †TP—closed, ‡CP Syn.—closed, CPMs—Nov. 4

Winter General Meeting
Hotel Statler
New York, N. Y.
January 29-February 3, 1961
(Final date for †TP—closed, ‡CP Syn.—Nov. 10, CPMs—Nov. 25)

AIEE-IRE-U of P International Solid-State Circuits Conference
University of Pennsylvania
Philadelphia, Pa.
February 15-17, 1961
(Final date for †TP—Nov. 17, ‡CP Syn.—Dec. 2, CPMs—Dec. 12)

AIEE-IAS-IRE-U of P Engineering Aspects of Magnetohydrodynamics Symposium
University of Pennsylvania
Philadelphia, Pa.
March 9-10, 1961

South East District Meeting
Jung Hotel
New Orleans, La.
April 5-7, 1961
(Final date for †TP—Jan. 5, CPMs —Jan. 30)

Rubber and Plastics Industries Conference
Sheraton Hotel
Akron, Ohio
April 10-11, 1961
(Final date for †TP—Jan. 10, ‡CP Syn.—Jan. 24, CPMs—Feb. 3)

Materials Handling Conference
Pick-Congress Hotel
Chicago, Ill.
April 11-12, 1961
(Final date for †TP—Jan. 11, ‡CP Syn.—Jan. 26, CPMs—Feb. 6)

Electric Heating Conference
Sheraton-Lincoln Hotel
Indianapolis, Ind.
April 11-12, 1961
(Final date for †TP—Jan. 11, ‡CP Syn.—Jan. 26, CPMs—Feb. 6)

Cement Industry Conference
Sheraton-Cadillac Hotel
Detroit, Mich.
April 18-20, 1961
(Final date for †TP—Jan. 18, ‡CP Syn.—Feb. 2, CPMs—Feb. 13)

Great Lakes District Meeting
Hotel Pick-Nicolett
Minneapolis, Minn.
April 19-21, 1961
(Final date for †TP—Jan. 19, CPMs —Feb. 13)

Rural Electrification Conference
Kentucky Hotel
Louisville, Ky.
May 1-2, 1961
(Final date for †TP—Jan. 31, ‡CP Syn.—Feb. 15, CPMs—Feb. 24)

AIEE-IRE-EIA-WCEMA Electronic Components Conference
Jack Tar Hotel
San Francisco, Calif.
May 2-4, 1961
(Final date for †TP—Feb. 2, ‡CP Syn.—Feb. 16, CPMs—Feb. 26)

AIEE-IRE-ACM Western Joint Computer Conference
Ambassador Hotel
Los Angeles, Calif.
May 9-11, 1961
(Final date for †TP—Feb. 8, ‡CP Syn.—Feb. 23, CPMs—Mar. 6)

North Eastern District Meeting
Statler Hotel
Hartford, Conn.
May 17-19, 1961
(Final date for †TP—Feb. 16, CPMs —Mar. 13)

AIEE-IRE Globe-Communication V Conference
Chicago, Ill.
May 22-24, 1961
(Final date for †TP—Feb. 21, ‡CP Syn.—Mar. 8, CPMs—Mar. 17)

Fractional Horsepower Motors Conference
Biltmore Hotel
Dayton, Ohio
May 23, 1961
(Final date for †TP—Feb. 22, ‡CP Syn.—Mar. 9, CPMs—Mar. 20)

Summer General Meeting
Cornell University
Ithaca, N. Y.
June 18-23, 1961
(Final date for †TP—Mar. 20, ‡CP Syn. Mar. 30, CPMs—Apr. 14)

Aero-Space Transportation Conference
Benjamin Franklin Hotel
Philadelphia, Pa.
June 26-30, 1961
(Final date for †TP—Mar. 28, ‡CP Syn.—Apr. 12, CPMs—Apr. 21)

Pacific General Meeting
Hotel Utah
Salt Lake City, Utah
August 23-25, 1961
(Final date for †TP—May 25, ‡CP Syn.—June 5, CPMs—June 19)

AIEE-ASME Engineering Management Conference
Hotel Roosevelt
New York, N. Y.
September 14-15, 1961
(Final date for †TP—June 16, ‡CP Syn.—June 30, CPMs—July 11)

Petroleum Industry Conference
Jung Hotel
New Orleans, La.
September 17-20, 1961
(Final date for †TP—June 19, ‡CP Syn.—July 5, CPMs—July 14)

Fall General Meeting
Statler-Hilton Hotel
Detroit, Mich.
October 15-20, 1961
(Final date for †TP—June 14, ‡CP Syn.—July 27, CPMs—Aug. 11)

*Final date for submitting papers—closed

†TP—Transactions Paper
‡CP Syn.—Conference Synopsis
CPMs—Conference Manuscript
DPMs—District Manuscript
(District Paper Synopses should be directed to the District Meeting Committee)

Transactions and conference papers must conform to the requirements in *Author's Guide*.
For a copy, write to E. C. Day, 33 W. 39th St., New York 18, N. Y.

Fortescue Fellowship Applicants Must File AIEE Forms by January 15

FUNDS have been made available for one or more Charles LeGeyt Fortescue Fellowship for 1961-62. The amount of the award has been fixed at $2,500. The awards are made to postgraduate students in the field of electrical engineering who have received their baccalaureate degrees from duly recognized technical schools in the United States or Canada.

Candidates for the Charles LeGeyt Fortescue Fellowship should file applications on the form provided by AIEE so that they may reach the chairman of the Fellowship Committee by January 15, 1961. Awards will be made not later than March 1, 1961. Copies of the application forms are available at accredited colleges or by writing to Mrs. A. L. Landres, secretary of the Professional Development and Recognition Department, American Institute of Electrical Engineers, 33 W. 39th St., New York 18, N. Y.

The Charles LeGeyt Fortescue Fellowship, sponsored by AIEE, was established in 1939 as a memorial to Charles Fortescue in recognition of his valuable contribution to the electric power industry. To this end, the Westinghouse Electric Corporation, with which Dr. Fortescue was associated throughout his professional career, set up a trust fund of $25,000 to provide graduate fellowships in electrical engineering.

The successful candidates are selected by the AIEE committee which administers the fund.

It is intended that candidates shall pursue their studies at accredited engineering schools and engage in research problems which meet the approval of the Fellowship Committee. To be eligible, the student must have received a bachelor's degree from an accredited college by the time his work under the fellowship would begin, provided he does not hold or subsequently receive any other fellowship which carries a stipend greater than the tuition required by the institution at which the graduate work is to be undertaken.

Engineering Aspects of MHD Will Be Discussed at Symposium

The 2nd Symposium on Engineering Aspects of Magnetohydrodynamics (MHD) will be held at the University of Pennsylvania, Philadelphia, Pa., on March 9-10, 1961. This meeting is sponsored by AIEE, the Institute of the Aeronautical Sciences, the Institute of Radio Engineers. The program is concerned with plasmas in the presence of magnetic field and, in particular, with the engineering aspects of this subject.

The primary purpose of the meeting is to exchange information among more or less related disciplines on the assumption that the participants will have some degree in competence in one or more broad areas. It is hoped that the meeting will be small enough so that extensive discussions may be permitted. Each session will have both invited and contributed papers. Authors of papers will assume audience familiarity with the field and concentrate on what is new, original, and novel in their particular contribution.

Four nonconcurrent sessions are planned covering (1) Communications and Diagnostics, (2) Flight Applications, (3) Fusion, and (4) Power Conversion. It is intended that the Communications and Diagnostics Session deal with the transmission and receiving of information or energy from plasmas under various conditions; that the Flight Applications Session deal with the propulsion or control of aerodynamic or space vehicles by MHD interaction between the vehicle and its environment; that the Fusion Session deal with the extraction of energy through controlled thermonuclear fusion of light nuclei; and the Power Conversion Session deal with the direct extraction of electric energy from hot flowing plasmas or conducting liquids.

Papers are desired for each of these sessions. Abstracts should be submitted to the appropriate session chairmen by November 25, as follows:

Communication and Diagnostics—C. B. Wharton, Lawrence Radiation Laboratory, Livermore, Calif.

Flight Applications—Dr. G. S. Janes, Avco Research Laboratories, Everett, Mass.

Fusion—Dr. C. W. Little, Atomic Energy Division, Allis-Chalmers Manufacturing Company, Milwaukee 1, Wis.

Power Conversion—Dr. G. W. Sutton, General Electric Company, Missile and Space Vehicle Department, Philadelphia 24, Pa.

The response to a questionnaire distributed after the first MHD Symposium indicated an overwhelming desire that authors' papers be available at the meeting. Acceding to this demand, the committee strongly encourages submission of a reproducible copy of each author's paper by February 1, 1961. These will be reproduced for distribution at the meeting.

In order to have a record of the symposium available in the technical literature, arrangements are being made to devote one issue of the AIEE *Transactions* to this use. Special consideration will be given to symposium papers which authors wish to have published in this issue, and the committee urges all authors to submit papers for this consideration.

GLOBECOM V Sponsors Issue Call for Technical Papers

The 5th National Symposium on Global Communications, to be known as GLOBECOM V, will be held May 22-24, 1961, at the Hotel Sherman, Chicago, Ill. The conference will be sponsored by the AIEE and the Professional Group on Communications Systems of the Institute of Radio Engineers (IRE).

Technical papers emphasizing the systems aspects of communications technology and related problems are being solicited. Some of the areas of interest include:

1. Transmission Systems—active and passive satellites, cables, forward scatter, microwave relay, and long haul trunks.
2. Techniques and Problems—digital data handling, propagation, modulation, multiplexing, and interference.
3. Systems Aspects—planning, economics, switching, trunking, and frequencies.

Abstracts of approximately 250 words, with a brief professional record of the author, should be submitted in duplicate by November 30 to: D. C. Campbell, Technical Program Committee, I.T.T.—Kellogg, 5959 S. Harlem Ave., Chicago 38, Ill.

At the symposium, oral presentation should require about 20 minutes, and 10 minutes will be allocated for discussion. Due to the broad scope of subject matter, groups of authors are invited to submit related abstracts. The Technical

Conference Papers Open for Discussion

Conference papers listed below have been accepted by AIEE *Transactions* and are now open for written discussion until November 25. Duplicate double-spaced typewritten copies of each discussion should be sent to E. C. Day, Assistant Secretary for Technical Papers, AIEE, 33 W. 39th St., New York 18, N. Y., on or before November 25.

60-181	**Digital Calculation of 3-Phase Short Circuits by Matrix Method.** *H. E. Brown, C. E. Person, L. K. Kirchmayer, G. W. Stagg*
60-225	**Thermal Relationships in an Induction Motor under Normal and Abnormal Operation.** *W. J. Martiny, R. M. McCoy, H. B. Margolis*
60-521	**Practical Applications of Digital Computers to Distribution Systems.** *T. L. Hatcher, E. L. Busby*
60-525	**Design of Transformer Vault Buses.** *R. O. Randle*

Preprints may be purchased at 50¢ each to members, $1.00 to nonmembers, if accompanied by remittance or coupons. Please order by number and send remittance to: AIEE Order Department, 33 W. 39th St., New York 18, N. Y.

Program Committee will endeavor to schedule all such parts, or make special provisions for a single presentation, should the material be of particular merit.

An abbreviated convention record will be prepared for use at the symposium. Authors will be encouraged to submit their full-length papers for later publication in the *Transactions* of the IRE Professional Group on Communications Systems, or the AIEE bimonthly *Communications and Electronics.*

Daily, newspaper headlines herald our progress in communications technology, especially on the satellite programs. The military and commercial implications of these and other more prosaic developments are being publicized widely. GLOBECOM V will afford an opportunity for recognition to the technical side of these advances, with the latest details provided by the final authorities, the authors.

Eta Kappa Nu Names Jury To Select Outstanding Engineer

Eta Kappa Nu, national electrical engineering honor society, has named seven nationally prominent engineering executives to comprise the Jury of Award to select the Outstanding Young Electrical Engineer of 1960 and Honorable Mentions.

For the 24 consecutive years since 1936, Eta Kappa Nu has honored the outstanding young electrical engineer in the country. Among those selected in the past were C. G. Suits, J. E. Hobson, Cledo Brunetti, R. W. Porter, and R. P. Crago.

Nominations are received from engineering schools, professional societies, industry, and individuals. To be eligible for the award, a candidate must be less than 10 years from his B.S. degree date and he must not have reached his 35th birthday by May 1 of the year in which he is being considered. The award is based not only on his professional engineering record but also on civic and national contributions, cultural and aesthetic achievements, as well as all other activities in which the candidate participates creatively as a hobby or in serving his fellow man.

The jury will review the top-ranking dossiers previously selected by an Award Organization Committee after an intensive prescreening review of all eligible nominees' records.

This year's jury comprises the following: W. R. Clark, assistant chief engineer, Leeds & Northrup Company, treasurer and director of AIEE; J. H. Craig, national vice-president of Eta Kappa Nu; E. I. Green, executive vice-president of Bell Telephone Laboratories, Inc., director of AIEE; J. C. McPherson, vice-president of International Business Machines Corporation; A. Naeter, national president of Eta Kappa Nu; R. G. Slauer, sales manager, Sylvania Electric Products, president of the Illuminating Engineering Society; and B. R. Teare, dean of Carnegie Institute of Technology, immediate past president of the American Society for Engineering Education.

800 Engineers and Scientists Attend Standards and Measurements Conference

MORE than 800 scientists and engineers from industry, universities, and Government participated in a Conference on Standards and Electronic Measurements, held June 22-24 at the Boulder (Colo.) Laboratories of the National Bureau of Standards (NBS). Sponsored by the AIEE, Institute of Radio Engineers, and the NBS, the 3-day meeting provided an opportunity for the exchange of information and ideas concerning the most recent developments in the field of electronics and measurements.

The technical program, under the chairmanship of Dr. G. E. Schafer of the Bureau's Boulder Laboratories, presented 40 papers during 6 technical sessions. These included: "Current and Future Problems in Standards and Electronic Measurements"; "Frequency and Time Standards"; "Methods of Measurement for Materials"; "Microwave Standards and Calibrations"; "Direct-Current and Low-Frequency Standards and Calibrations"; and "High-Frequency Standards and Calibrations." Among the more important and interesting topics covered were standards and measurement techniques for electrical quantities at frequencies ranging from direct current through the microwave region, the most pressing current problems in establishing universally accepted consistent standards, and a considered speculative look at the most probable causes of difficulty in the future in making standards and electronic measurements.

Emphasis Placed on Accuracy

Advances in the field of standards and measurements, since the first such conference in Boulder in August 1958, have served to emphasize the need for constant effort to improve accuracy in electronic measurements and standards. In addition to the continuing problems in large-scale precision production of electronic equipment, instruments, and systems—including major parts of aircraft control, rocketry, and missile guidance—the advent of space vehicles has brought to the fore the need for highly specialized electronic systems whether the vehicle be manned or unmanned. For satisfactory operation, the separate components of these different systems must be chosen particularly for their function and constructed and evaluated according to accurate reference standards. Very slight deviations from electronic specifications may result in complete failure of a missile or other device.

In the past 2 years, tremendous strides have been made in developing and applying industry-wide standards, but the electronic industry keeps expanding so rapidly that it has been impossible for research in electronic standards to keep pace. Furthermore, interchange of information has lagged behind the acquisition of such information, with resulting differences between reference standards developed by one organization and those of another. Uncertainties and variations in electric standards and radio materials have resulted in electronic units being built and used without precise knowledge as to how well they will operate or how long they will last.

The critical importance of common standards, adopted by all, was emphasized by the technical sessions of the conference. Large attendance, lengthy private discussions, and the exchange of questions and answers between platform and floor made it clear that both industry and government are aware of the urgent need for universally accepted, consistent measurement standards in the electronic field on a still more advanced level than ever before.

Systematic Approach Needed

Dr. F. W. Brown, director of the Boulder Laboratories, opened the conference. He was introduced by Conference Chairman I. G. Easton of General Radio Company. In his opening address, Dr. Brown discussed the importance of standards and measurement techniques to electronics and emphasized the need for a systematic approach to the wide range of standards and measurements problems associated with the field.

The participants also heard a talk by Dr. B. M. Oliver of Hewlett-Packard Company at the conference luncheon on June 23. Dr. Oliver reviewed the role of quantitative measurement in the development of the sciences. He stressed the importance of precise measurement in exploring second-order effects that might not be revealed by less precise experimentation, and the co-operation of science and technology to provide the precision instruments needed for further research. He also pointed out that in many cases, science can be over-precise, resulting in unnecessary complexity and expense, where less precision could still provide adequate performance of equipment.

Technical Papers Sought For Joint Computer Conference

Technical papers at the 1961 Western Joint Computer Conference will be presented in the areas of systems, applications, and circuitry for both digital and analog computers, C. T. Leondes, program chairman for the annual conference, has announced.

Calling for papers from technical and academic personnel, Mr. Leondes cited the conference's theme, "Extending Man's Intellect," to emphasize the role that computers have played in scientific, technical, and business advances in recent years.

Mr. Leondes expects papers in a wide range of subjects, including medical uses of computers, automatic programming, pattern recognition, automation theory, language data processing, thin film memory devices, cryogenic devices, large-scale computer systems, neural models, and solid-state devices and circuits.

Detailed summaries of papers should be submitted by December 15, 1960, to C. T. Leondes, associate professor of engineering, Department of Engineering, University of California, Los Angeles 24, Calif.

The conference has been slated for May 9-11, 1961, at the Ambassador Hotel in Los Angeles.

Tentative Program Given for Western Appliance Conference

The AIEE Western Appliance Technical Conference will be held November 7 at the Biltmore Hotel, Los Angeles, Calif.

A tentative program for this conference follows:

9:30 a.m. Morning Session

The Role of the Product Service Department in Product Design. *H. R. Clark,* Waste King Corp.

The Relationship of Product Reliability to the Product's Market. Speaker to be selected

Corporate Aspects of Product Warranties. *Herbert Leo,* Utility Appliance Corp.

Direct Spark Ignition for Gas Appliances. *Paul Neess,* Controls Corporation of America

Designing Two Appliances in One. (Gas and Electric Laundry Appliances) *Raymond Goodman,* Whirlpool Corp.

12:00 a.m. General Luncheon

Speaker: Henry Dreyfuss will talk on "An Industrial Designer Looks at Appliances."

2:00 p.m. Afternoon Session

Present and Future Application of Semiconductor Devices in the Appliance Industry. *R. P. Abraham,* Texas Instruments Inc.

Shock Hazard Testing. *K. S. Geiges,* Underwriters' Laboratories, Inc.

A Picture of National Utilization Voltages and Effects on Appliance Design. Speaker to be selected

Application of Shaded Pole and Permanent Fixed Capacitor Motors to Direct Driven Blowers. *John Smaxwell,* General Electric Co.

7:30 p.m. Evening Session

Panel discussion on "What We Expect from an Appliance" by prominent authorities in various fields.

Speakers will represent: Home Equipment editor of magazine, consumer publication, utilities (electric and gas), home builder, listing and approval agencies (Underwriters' Laboratories and American Gas Association), and user.

Each speaker is to have a maximum of 10 minutes for his formal presentation, and a question and discussion period will follow after all panel participants have spoken.

Magnetism Conference Scheduled for November 14-17

The 6th Annual Conference on Magnetism and Magnetic Materials, sponsored by the AIEE and the American Institute of Physics, will be held at the Hotel New Yorker, New York City, from November 14 to 17. As in the past, this conference is expected to attract more than 1,000 engineers, physicists, chemists, and metallurgists from all parts of the world to discuss fundamental and applied research in the field. About 160 technical papers, covering all phases of magnetism, are included in the program. Ten invited papers will be read by outstanding scientists from the United States, Japan, Holland, France, and England.

Among the topics to be discussed are the formation of thin films of magnetic materials and their application as memory units for computers, the study of magnetic resonance phenomena, magnetic ordering in helical spin systems, and the properties of magnets made of particles of extremely small size.

On the evening of November 16, the annual banquet of the conference will be addressed by Dr. T. K. Glennan, head of the National Aeronautics and Space Administration, who will discuss some of the problems in the successful operation of space systems.

A regular feature of this conference is the exhibit of new equipment, materials, and books. To date, 20 exhibitors have leased 28 exhibition booths.

Those interested in attending should write to Dr. L. R. Bickford, Jr., IBM Research Center, P. O. Box 218, Yorktown Heights, N. Y.

Dunstan Hall Is Dedicated in Presentation to University

Housing the departmental offices of electrical engineering and several of its laboratories, Dunstan Hall at Auburn University, Auburn, Ala., was dedicated October 14. Dunstan Hall is the first unit to be completed of a large expansion of the physical plant at Auburn University.

This new facility was named Dunstan Hall in memory of Arthur St. Charles Dunstan, head of the department of electrical engineering at Alabama Polytechnic Institute during 1899-1951. Prof. Dunstan's electroscope, which he used to detect radium, led to the recovery of more than $75,000 worth of radium that had been lost or mislaid.

P. S. Haley, vice-chairman of the Board of Trustees at Auburn University, presided at the dedication ceremonies and made the presentation of Dunstan Hall. Dr. R. B. Draughon, president of the university, accepted the new structure. Addresses were made at the dedication ceremonies by C. B. McManus, chairman of the board of the Southern Company, and Dr. B. S. Gilmer, president of the Southern Bell Telephone and Telegraph Company. The dedicatory prayer was given by the Rev. F. S. Persons, Montgomery.

Dunstan Hall was open for inspection immediately following the dedication ceremonies.

A 3-story reinforced concrete frame building with masonry fill-in, the Hall provides classrooms, laboratories, and offices for the rapidly growing student body and enlarging faculty. During the 1950's, the number of engineering students more than doubled—to 3,233 in 1957-8. The new building houses offices and laboratories of the Departments of Electrical Engineering and Industrial Management, the Department of Foreign Languages, the new Department of Philosophy, and a part of the Department of Economics and Business Administration.

The structure is of simple, standard classroom design which lends itself to economical construction and variable uses. It is the first completely air-conditioned building constructed on the Auburn University campus. Construction was started in March 1959 and completed for occupancy in December. Located on Duncan Street, immediately west of the three shop buildings, it is conveniently near both the engineering group of buildings and the center of the campus.

Advanced to AIEE Fellow Grade

RECEIVING his Fellow certificate from A. J. Hornfeck (*left*), Cleveland Section chairman, is C. F. Paulus (*right*), general supervising engineer, Plant Engineering Section, Cleveland Electric Illuminating Company. The presentation took place at a Section meeting.

AIEE FELLOWS ELECTED

Board of Directors Meeting, September 20, 1960

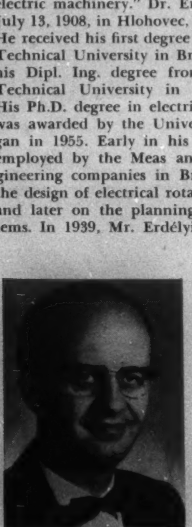
Clifford Charles Diemond (AM '37, M '45), substation maintenance supervisor, Bonneville Power Administration (BPA), Portland, Oreg., has been transferred to the grade of Fellow in the AIEE ". . . for contributions to power system protection." Mr. Diemond was born August 9, 1914, in Pasco, Wash., and received the B.S. degree in electrical engineering in 1935 from the University of Washington. After graduation, he joined the U. S. Bureau of Reclamation Columbia Basin Project where he worked as a civil engineer. In 1939, he transferred to the Bonneville Power Administration where he served successively in substation design, relay maintenance, and substation maintenance. His work with Bonneville has included equipment control design, relay maintenance and performance analysis, and electrical equipment maintenance. He was responsible for the development of many of the procedures used on the BPA system for relay settings, system fault tests of circuit breakers and relays, high-voltage insulation maintenance, and equipment performance and maintenance work measurement systems. Mr. Diemond is a member of the National Society of Professional Engineers and the Professional Engineers of Oregon. He is a registered professional engineer in the State of Oregon. He has served as chairman of the Portland Section, AIEE (1959-60).

Edward A. Erdélyi (M '46), professor of electrical engineering, University of Delaware, Newark, Del., has been transferred to the grade of Fellow in the AIEE ". . . for contributions to the theory of noise in electric machinery." Dr. Erdélyi was born July 13, 1908, in Hlohovec, Czechoslovakia. He received his first degree from the Czech Technical University in Brno in 1926 and his Dipl. Ing. degree from the German Technical University in Brno in 1929. His Ph.D. degree in electrical engineering was awarded by the University of Michigan in 1955. Early in his career, he was employed by the Meas and Elektron engineering companies in Brno, at first on the design of electrical rotating machinery and later on the planning of power systems. In 1939, Mr. Erdélyi became chief-engineer of the EFI, S. A., in Evreux, France. He was associated with the staff of the Directorate of Scientific Research and Technical Development, Royal Aircraft Establishment, in Farnborough, England, in 1940. In 1947, he joined the Newark College of Engineering, and in 1950 was appointed assistant professor of electrical engineering at Washington University in St. Louis, Mo. Two years later, he was employed by Syracuse University as professor of electrical engineering. In 1956, Dr. Erdélyi joined the Advance Engineering Laboratory of the General Electric Company in Erie, Pa., as a senior analytical engineer. In 1959, he was appointed to the H. Rodney Sharp Chair of Electrical Engineering in the University of Delaware. Dr. Erdélyi is a registered professional engineer in the State of New York and a member of the American Society of Mechanical Engineers, the Institution of Electrical Engineers in England, the Franklin Institute, the American Association of University Professors, the American Society for Engineering Education, Eta Kappa Nu, and Sigma Xi.

G. Everett Farmer (AM '46, M '50), chief of the Communication and Design Branch of the Tennessee Valley Authority (TVA), Chattanooga, Tenn., has been transferred to the grade of Fellow in the AIEE ". . . for contributions to the development of a comprehensive communication system for a large power system." He was born November 7, 1898, in Cambridge, Mass., and received the B.S. degree in electrical engineering in 1922 from the Massachusetts Institute of Technology. For 2 years, he worked as a field engineer for the Pacific Telephone and Telegraph Company in Los Angeles, Calif. During 1924-31, he was employed by the Southern California Edison Company as a supervisor of communication design. In 1931-38, he was an electrical and communications engineer with the Metropolitan Water District of Southern California at the Colorado River Aqueduct. In 1938, he joined the TVA in Chattanooga as assistant to the head of the Communication Section of the Power Engineering and Design Branch. In 1950, this section was raised to full branch status and Mr. Farmer was made chief. The TVA system for which he is now responsible consists of more than 66,000 circuit miles of telephone, teletypewriter, pilot relaying, telemetering, facsimile, supervisory control, telautograph, and data-transmission equipment. He is a member of the Tennessee Society of Professional Engineers and of the Chattanooga Engineers Club. Mr. Farmer has served on the following AIEE Committees: Power System Communications (1950-60, chairman 1958-60), Substations (1957-60), and Power Division (1958-60)

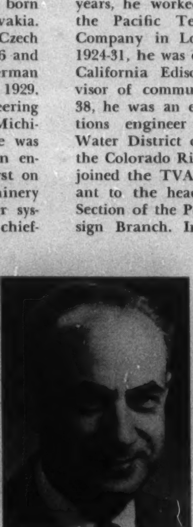
Samuel Farrell Henderson (M '46), manager, a-c motor development engineering, motor engineering department, Westinghouse Electric Corporation, Buffalo, N. Y., has been transferred to the grade of Fellow in the AIEE ". . . for contributions to the improvement of induction motors." Born November 16, 1904, in Chicago, Ill., he graduated from the Illinois Institute of Technology in 1926 with the B.S. degree in electrical engineering. He joined the Westinghouse Electric Corporation, East Pittsburgh, Pa., in 1926 as a graduate student, and after courses in the engineering and design schools became an a-c motor design engineer. Mr. Henderson has worked on the design and development of totally enclosed fan-cooled and explosion-proof motors used widely in the automotive, chemical, petroleum, and steel industries. Designs of many types of special motors for applications such as the Queens Midtown Tunnel ventilating fan drives and steel mills in runout tables and coilers were made, put into production, and successfully operated. In his present position, he has supervised the design and development of new and major lines of a-c motors. Mr. Henderson has the responsibility for design direction of new lines of motors valued at approximately $20 million a year. He is a member of Eta Kappa Nu, and has served on the AIEE Rotating Machinery Committee (1951-60).

S. W. Herwald (AM '46, M '49), vice-president, research, Westinghouse Electric Corporation, Pittsburgh, Pa., has been transferred to the grade of Fellow in the AIEE ". . . for contributions to the theory and development of servomechanisms." Born January 17, 1917, in Cleveland, Ohio, he received the B.S. degree in 1938 from the Case School of Applied Science and

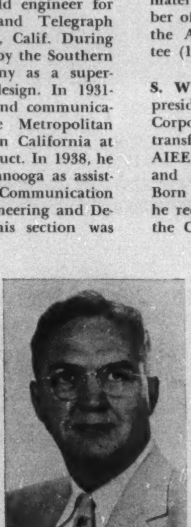


J. C. Moreland

C. C. Diemond

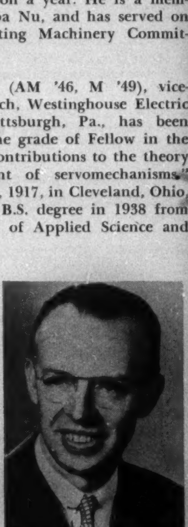


E. A. Erdelyi



Ed. Forstner

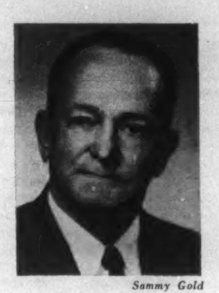
G. E. Farmer



S. F. Henderson

Fabian Bachrach

S. W. Herwald


Sammy Gold

M. H. Lovelady

F. J. Maginniss

T. E. Marburger

the M.S. degree in 1940 from the University of Pittsburgh, both in mechanical engineering. During 1939-47, he was an engineer in the Central Engineering Department of Westinghouse Electric Corporation in East Pittsburgh, where the main effort was devoted to ordnance development with special emphasis placed on servomechanism development. In 1947, he was advanced to section manager, Special Products Development Division, at Westinghouse, engaged in ordnance development. Mr. Herwald became engineering manager of this division in 1951, and engineering manager, Air Arm Division of Westinghouse in Baltimore, Md., in 1952. Four years later, he was promoted to manager of the Air Arm Division, and in 1959, took his post as vice-president, research, for Westinghouse. He is a Fellow of the Institute of Radio Engineers, a member of the American Society of Mechanical Engineers, chairman of the Airborne Electronics Section of the American Ordnance Association, and a member of the U. S. Air Force Scientific Advisory Board. He is a member of Sigma Xi and a registered professional engineer in the State of Pennsylvania. Mr. Herwald has served on the following AIEE Committees: Feedback Control Systems (1949-60, chairman 1950-52); Industry Division (1950-52); Research (1959-60); and Basic Sciences (1959-60).

Marcus Henry Lovelady (AM '30, M '50), vice-president and chief engineer, Central Power and Light Company, Corpus Christi, Texas, has been transferred to the grade of Fellow in the AIEE ". . . for contributions to the Southwest Power Pool Interconnected System and to engineering and management of an expanding power system." Mr. Lovelady was born September 26, 1903, in Tyler, Texas. He started with the Texas Power and Light Company in 1923 as a draftsman and was soon assigned the job of design of relay and control scheme for substations and transmission lines. In 1926, he went to work for the Central Power and Light Company, San Antonio, Texas, as a transmission and substation design engineer, and in 1938 was transferred to the Central Power and Light Company home office in Corpus Christi, Texas. During World War II, Mr. Lovelady was the company representative on the Southwest Operating and Interconnected Systems Committee. He was instrumental early in 1942 in organizing the South Texas Interconnected Systems power pool and has since been active in guiding its operation. Mr. Lovelady was appointed assistant chief engineer of the Central Power and Light Company in 1945 and chief engineer in 1952. He was elected vice-president in 1954 and a director in 1955. He is a registered professional engineer in the State of Texas. Mr. Lovelady has served on the following AIEE Committees: Protective Devices (1936-37), System Engineering (1947-57), and Industrial Power Systems (1951-52).

Frank Joseph Maginniss (AM '43, M '48), manager of special studies and digital analysis engineering in the Electric Utility Analytical Engineering Operation, General Electric Company, Schenectady, N. Y., has been transferred to the grade of Fellow in the AIEE ". . . for contributions to the application of digital computers in solution of engineering problems." He was born May 6, 1909, in Rutherford, N. J. Since 1941, he has been employed at the General Electric Company, Schenectady, N. Y. During 1941-51, he was an application engineer in central station engineering, assigned to the application of mechanical differential analyzer and digital computers to the solution of a variety of engineering problems. In 1951, he became manager of special investigations, analytical engineering, responsible for directing the activities of engineers and programmers in the solution of problems which involved mostly solution by digital computer. Mr. Maginniss was assigned this present post in 1958. Mr. Maginniss is a licensed engineer in New York State and is a member of the Institute of Radio Engineers and of the Association for Computing Machinery. He has served on the AIEE Computing Devices Committee (1950-60, chairman 1953-55) and Science and Electronics Division Committee (1953-58).

Thomas Edwin Marburger (AM '38, M '42), vice-president—engineering and construction, Baltimore Gas and Electric Company, Baltimore, Md., has been transferred to the grade of Fellow in the AIEE ". . . for contributions to the management of construction, operation, and engineering of a major electric utility system." Mr. Marburger was born January 28, 1901, at Point Patience, Calvert County, Md. He was graduated in 1943 with the B.S. degree in electrical engineering from Johns Hopkins University. In 1922, he was employed by the Consolidated Gas, Electric Light, and Power Company of Baltimore, which became the Baltimore Gas and Electric Company in 1955, and was assigned to the electrical engineering and test departments as a student apprentice and testman. During 1923-41, Mr. Marburger held the positions of inspector, assistant to the superintendent, and superintendent, successively, in the electric construction department. He was assigned as engineer in electric production in 1941-44 and operating assistant to general superintendent—electric in 1944-51. He was on leave of absence in May-November 1951 when he served with the Defense Electric Power Administration in Washington, D. C., as director of the Materials and Equipment Division for the electric utility industry. In 1957, Mr. Marburger was appointed general superintendent, and in 1960, vice-president—engineering and construction, with full executive responsibility for electrical engineering and construction. He is a registered professional engineer in the State of Maryland, and holds memberships in the American Society of Mechanical Engineers, the Engineers Club of Baltimore, the Maryland Academy of Science, and the American Meteorological Society. He is a director for Atomic Power Development Associates.

John Burns McClure (AM '29, M '47), manager, power generation engineering, electric utility systems engineering, General Electric Company, Schenectady, N. Y., has been transferred to the grade of Fellow in the AIEE ". . . for contributions in the field of electric utility generating stations and power transmission systems." He was born December 6, 1900, in Thamesford, Ont., Canada. In 1923, he received the B.S. degree from Queen's University, and in 1927, the M.S. degree from the Massachusetts Institute of Technology, both in electrical engineering. Mr. McClure joined General Electric in 1923, and participated in the test course and the advanced course in engineering. Following an assignment in steam turbine design, he transferred to Central Station Engineering in 1927, where his work involved investigation of lightning surges on transmission lines, early applications of automatic frequency control, and power system stability analysis of the Hoover Dam—Los Angeles 287.5-kv transmission lines and associated hydro-generators. His work included design of auxiliary power systems and excita-

J. B. McClure

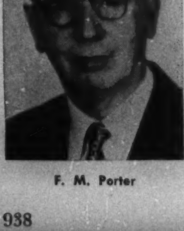
tion systems for steam-electric stations, the application of large turbine generators to modern power systems, and design of the electric system for the floating power plants in 1942. He was made manager of power generation engineering in 1947, which involved power generation economics and equipment characteristics for hydro plants, gas turbine plants, steam-electric generating plants, and nuclear plants. Mr. McClure is a member of the American Society of Mechanical Engineers, the National Society of Professional Engineers, and a registered professional engineer of the State of New York. He has served on the following AIEE Committees: Power Generation (1946-56, chairman 1953-55), liaison representative on Standards (1951-54); and Power Division (1953-55).

Frederick Meredith Porter (AM '36, M '45), consulting electrical engineer, American Electric Power Service Corporation, New York, N. Y., has been transferred to the grade of Fellow in the AIEE ". . . for contributions to hydrogen cooling of synchronous condensers and generators, excitation systems and high voltage transmission." Mr. Porter was born December 23, 1895, in York, Pa., and graduated from Lehigh University in 1920 with the B.S. degree in electrical engineering. He worked a year each with the Westinghouse Electric Corporation and the Pennsylvania Power and Light Company on electrical construction, and the following 4 years served as assistant electrical engineer and electrical engineer for the Pennsylvania Edison Company, Easton, Pa., on electrical construction and operation. In 1926, he joined the American Gas and Electric Company in New York as a senior electrical engineer. In 1945, he became head of the Station and Equipment Section. During 1954-58, he was chief electrical engineer in charge of supervising the work of the Electrical Engineering Division. Since 1959, he has been consulting engineer for the American Electric Power Service Corporation. He is a registered professional engineer in the State of New York and has served on the AIEE Rotating Machinery Committee (1953-60).

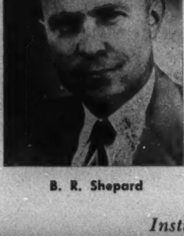
Billy R. Shepard (AM '41, M '48), manager of the Computer Engineering Operation of the ordnance department of the General Electric Company in Pittsfield, Mass., has been transferred to the grade of Fellow in the AIEE ". . . for contributions to guidance systems and associated computers." Born April 10, 1918, in Denver, Colo., he was educated at the University of Colorado from which he received the B.S. degree in electrical engineering in 1940. Mr. Shepard joined General Electric in Schenectady, N. Y., in 1940, and up to 1955, worked on the development of high-frequency sonar equipment and special measuring and control equipment in the General Engineering Laboratory. During 1948-55, he was supervisor of the Electro Mechanical Product Development Unit of the laboratory, in which the products ranged from special vibration and shock equipment to automatic generation allocation and load-frequency control equipment for power systems. In 1955, he joined the missile and ordnance systems department as manager of the Electronic Control Components Operation, where he worked on guidance and control equipment for Sargent, Atlas, and Polaris missile systems. In 1957, he became manager of the Computer Engineering Operation of the ordnance department in Pittsfield, concerned with the development of guidance and fire control computing and data-handling equipment for the Polaris missile system. He is a senior member of the Institute of Radio Engineers, a member of the National Society of Professional Engineers, and a registered professional engineer in the State of New York.

Henry Whitfield Smith (M '29), executive vice-president and director, International Power and Engineering Consultants, Ltd., Vancouver, B.C., Canada, has been transferred to the grade of Fellow in the AIEE ". . . for contributions to development of a large electric power system." He was born January 6, 1902, in Reading, England. Mr. Smith joined the staff of the Toronto Hydro-Electric System as an electrical station designer in 1922, and served this utility for 23 years. He was in responsible charge of all station electrical design for the last 9 years. In 1945, he joined the British Columbia Electric Company, Ltd., in Vancouver as protections engineer and stations design engineer, and 2 years later was advanced to assistant chief engineer, Electrical Division. He was appointed assistant general manager, British Columbia Engineering Company, Ltd., in 1957, and a year later to the position of general manager. In 1960, this company was merged to form the International Power and Engineering Consultants Ltd., and at that time, Mr. Smith assumed his present position. He has had major responsibilities in connection with the planning and engineering of the principal electric, transportation, and gas facilities which have been constructed for British Columbia Electric Company, Ltd., during the last 15 years. These have included the world's longest 138,000-volt submarine cable installation across the Straits of Georgia, the continent's highest voltage transmission system from Vancouver to Shalalth, and an extensive underground cable installation. He is a member of the AIEE Transmission and Distribution Committee (1956-59).

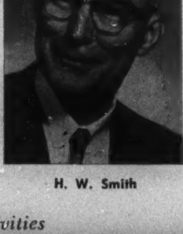
Louis Nelson Stone (AM '40, M '50), head of the electrical engineering department, Oregon State College, Corvallis, Oreg., has been transferred to the grade of Fellow in the AIEE ". . . for contributions to undergraduate and graduate electrical engineering education and to research in the area of high-voltage phenomena." Prof. Stone was born June 18, 1914, in Wasco, Oreg., and received the B.S. degree in electrical engineering in 1939 from Oregon State College. Following graduation, he was employed by the Caterpillar Tractor Company, Peoria, Ill., in the engineering orientation program and as an electrical engineer. During 1942-46, he was associated with the Submarine Signal Company, Boston, Mass., as field engineer, West Coast supervisor, and design engineer. In 1946, he was employed as an electrical engineer with the Marine Division of Kirsten, Seattle, Wash. Since 1947, he has been at Oregon State College as assistant professor of electrical engineering, associate professor of electrical engineering, and professor and head of electrical engineering, successively. He is in



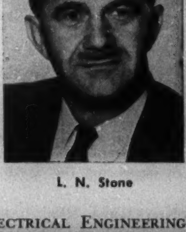
F. M. Porter



B. R. Shepard



H. W. Smith



L. N. Stone

charge of high-voltage and plasma research in the electrical engineering department. He is a registered professional engineer in the State of Oregon, and a member of the Institute of Radio Engineers, the Association for Computing Machinery, the American Society for Engineering Education, the Professional Engineers of Oregon, the National Society of Professional Engineers, Eta Kappa Nu, Pi Mu Epsilon, Sigma Tau, and Sigma Xi. He has served on the following AIEE Committees: Instruments and Measurements (1950-52), Student Branches (1951-60), Education (1955-60), Recording and Controlling Instruments (1956-60), and Research (1959-60).

Francis Ottly Wollaston (AM '27, M '43), consultant to International Power and Engineering Consultants, Ltd., Vancouver, B.C., Canada, has been transferred to the grade of Fellow in the AIEE ". . . for contributions to design of transmission at extra high voltages; overhead, underground and underwater." Mr. Wollaston was born March 26, 1903, in Victoria, B.C., Canada. He received the B.S. degree in electrical engineering in 1925 and the electrical engineering degree in 1931, both from the University of Washington. Mr. Wollaston began his career in 1925 with the Commonwealth Edison Company, Chicago, Ill., where he was employed successively as a field engineer, design engineer, engineer of the Equipment and Research Section, and supervising engineer. In 1943, he returned to his native province to become superintendent, transmission and distribution department, British Columbia Electric Company Ltd. In 1950, he was promoted to superintendent, engineering design department, where he was in charge of station electrical design, transmission and distribution design, civil engineering and mechanical engineering sections. Four years later, he was made superintendent, electrical design department, for the British Columbia Engineering Company, an affiliate of the British Columbia Electric Company. Mr. Wollaston was promoted to chief of the electrical engineering department in 1956, and is presently consultant to International Power and Engineering Consultants, a new company, occupied with design projects. He is past co-ordinating chairman of the Transmission and Distribution Section of the Canadian Electrical Association and a member of Tau Beta Pi. Mr. Wollaston has served on the AIEE Standards Committee (1959-60) and Transmission and Distribution Committee (1959-60).

Williams Bros.

F. O. Wollaston

AIEE PERSONALITIES

T. J. Allen (AM '50) has been appointed chief engineer—electrical of S. W. Brown, Consulting Engineers, New York, N. Y. Mr. Allen was formerly with Voorhees, Walker, Smith, Smith, and Haines.

A. A. Baechle (AM '57) has been appointed a staff engineer of the National Industrial Service Association, Inc. Mr. Baechle had been employed as an application engineer by the Allis-Chalmers Manufacturing Company, Norwood, Ohio. He joined the association's St. Louis, Mo., headquarters staff on September 1.

W. H. Boyce (M '47) has been appointed a new executive vice-president in charge of the Industries Division of the Royal Electric Manufacturing Company, Chicago, Ill. Mr. Boyce came to Royal from the Delta-Star Electric Division.

B. W. Bryan (AM '52) is now employed as a sales engineer for the Arthur Wagner Company of Chicago, Ill.

R. A. Conover (AM '53), an engineer with the Public Service Electric and Gas Company, Newark, N. J., since 1948, has been appointed an assistant professor of mechanical engineering at Lafayette College.

J. M. Constable (M '44) has been appointed division manager of the Instrument and Research Division, Nuclear Corporation of America. Mr. Constable was recently with the Electronic Products Company.

E. V. Diercks (AM '51) has been appointed sales application engineer of the Fisher-Pierce Company, South Braintree, Mass.

E. E. Farrell (AM '55) has been promoted to the position of regional sales manager of Motorola Semiconductor Products Inc. He will supervise Motorola product sales throughout the western region of the United States, with headquarters in Hollywood, Calif. Previously, Mr. Farrell was manager of district sales for Motorola in the South Central area of California.

R. J. Jeffries (AM '46), president of Data-Control Systems, Inc., Danbury, Conn., has been appointed a member of an ad hoc committee established by the Division of Engineering and Industrial Research of the National Academy of Sciences—National Research Council to prepare an analysis of the role of patents in research. Other members of the committee are: **H. A. Leedy** (M '46), Armor Research Foundation; **T. M. Linville** (AM '27, F '47), research operations manager of General Electric's Research Laboratory, Schenectady. Dr. Jeffries has served on the AIEE Recording and Controlling Instruments Committee (1956-60). Mr. Linville has been an AIEE director (1953-57), and has served on the following AIEE Committees: Education (1947-49, 1958-60, chairman 1958-59); Finance (1954-57, chairman 1956-57); Research (1957-60); Engineers Council for Professional Development (1958-61); and Planning and Co-ordination (1959-60).

R. R. Jenner (AM '39, M '48) has joined Mechanical Products, Inc., at Jackson, Mich., as vice-president, sales and engineering. Mr. Jenner was previously director of airborne projects for Micro Switch, a division of Minneapolis-Honeywell of Freeport, Ill.

F. L. Kahn (M '42), director of the telephone switching systems development department of Automatic Electric Laboratories, Northlake, Ill., has been presented with Automatic Electric's highest honor, the Talbot G. Martin Award. The annual award was made by the Strowger Automatic employee clubs in recognition of his "outstanding contribution to the art and science of communications."

Chester Kirka (AM '51, M '58) has been promoted to chief engineer of the X-Ray Tube Section of the Machlett Laboratories, Inc. He had been responsible for Machlett X-ray and electron tube sales and applications engineering activities throughout the Eastern states. In his new post, Mr. Kirka is responsible for the research, development, and product engineering of Machlett's line of X-ray tubes. He has served on the AIEE Electrical Techniques in Medicine and Biology Committee (1956-60).

Edwin Langhenry (AM '51), formerly midwestern regional sales manager of Erico Products, Inc., Cleveland, Ohio, has been appointed national sales manager for three Erico divisions—Cadweld Electrical Connection, Caddy Arc Welding Accessory, and Caddy Toggle Clamp.

Reuben Lee (AM '53, M '54), consulting engineer at the Westinghouse Electric Corporation's Electronics Division, has been given the company's highest award in recognition of notable technical accomplishments including the development of the first radar pulse transformer.

L. J. Linde (AM '39, F '51) has been named director of engineering services, Allis-Chalmers Manufacturing Company, Milwaukee, Wis. Mr. Linde was made responsible for the formation of a technology group, which includes certain of the company's engineering laboratories,

Membership in the American Institute of Electrical Engineers, including a subscription to this publication, is open to most electrical engineers. Complete information as to the membership grade, qualifications, and fees may be obtained from Mr. N. S. Hibshman, Secretary, 33 West 39th Street, New York 18, N.Y.

Named "Engineer of the Year"

Dan Owen

NEW YORK'S "engineer of the year" award for 1960 was recently presented to (*left*) G. B. Warren (M '58), a General Electric Company vice-president and consulting engineer for the Turbine Division, Schenectady. Presentation of a plaque was made by Victor Hall (*right*) of Syracuse, president of the state's Society of Professional Engineers at the society's Fall meeting in Watertown. The society recognized Mr. Warren for his pioneering and engineering leadership in gas, steam, and marine propulsion turbines and aircraft jet engines.

the engineering analysis section, and the engineering standards section. In 1957, he assumed the position of manager, C Stellarator Associates, a special group of Allis-Chalmers and Radio Corporation of America engineers and scientists engaged in fusion research at Princeton University. Mr. Linde has served on the AIEE Nucleonics Committee (1959-60).

A. F. Lopez (M '50), has been appointed head of the newly created Intelligence Systems department of HRB-Singer, Inc., a unit of Singer Military Products Division of the Singer Manufacturing Company. Mr. Lopez joined HRB-Singer in 1952 and was formerly section manager.

E. L. Lotz (AM '38, M '44) has been appointed to the newly created position of vice-president in charge of research and development of Hess, Goldsmith & Company, Inc. Dr. Lotz was formerly Hess, Goldsmith research director and general manager of Glass Fabrics Finishing Company, Cedar Grove, N. J., a division. He will continue to make his headquarters at Cedar Grove.

W. M. Lyford (AM '54), area representative of Daystrom, Inc., in the northeastern United States, has been named systems engineering co-ordinator.

T. A. Lyon (AM '53) has been named general manager of Vacuum Ceramics, Inc., Cary, Ill. Mr. Lyon was formerly vice-president in charge of operations for DuBois Engineering and Manufacturing Corporation, Hammond, Ind.

R. W. MacKay (AM '54) has been named chief engineer for generators, a principle product of the Electric Autolite Company, Toledo, Ohio. He joined Autolite in 1952.

D. D. Mallory (AM '31, M '45) has been named manager of product operations for the Components Division of Hughes Aircraft Company. Mr. Mallory will be responsible for the production of parametric amplifiers and microwave components developed by the division's electrophysics laboratory. He has been with Hughes since 1957 in various engineering and development positions.

T. H. Mansfield (AM '50) has been appointed chief engineer of Servomechanisms Inc., El Segundo, Calif. Mr. Mansfield was formerly manager of the guidance controls department at Hughes Aircraft Company.

T. E. Marburger (AM '38, M '42), vice-president, engineering and construction, Baltimore Gas and Electric Company, Baltimore, Md., has been elected a member of the board of directors of the Atomic Power Development Associates, Inc.

J. W. Margosian (AM '44), formerly in charge of the systems program for Polarad Electronics Corporation, New York, N. Y., has been named vice-president for engineering of Microwave Dynamics Corporation, Plainview, N. Y., a subsidiary of Talley Industries, Inc., Cheshire, Conn.

D. R. Maure (AM '50) has been appointed director of engineering for Telemetrics, Inc.

D. T. McRuer (AM '49, M '57), president of Systems Technology, Inc., will receive the Louis E. Levy Medal from the Franklin Institute for the paper, "The Human Operator as a Servo System Element," which appeared in the Journal of the Franklin Institute this year. The paper was written jointly with E. S. Krendel, head of the Engineering Psychology Branch of the Franklin Institute Laboratories, who will also be awarded the Louis E. Levy Medal.

A. G. Mellor (AM '37, M '52) has been named project engineer for General Electric's newly formed power plant engineering operation. Mr. Mellor had been senior application engineer in the Power Generation Engineering Unit of General Electric's Electric Utility Engineering Section. He has served on the AIEE Power Generation Committee (1956-60).

G. J. Murphy (AM '50) has been promoted to full professor and chairman of the electrical engineering department of the Technological Institute at Northwestern University. At Northwestern since 1957, Dr. Murphy had been associate professor.

N. B. Nichols (M '51), vice-president and chief engineer, Taylor Instrument Companies, Rochester, N. Y., was named a Fellow of the Instrument Society of America for "contributions to the science of pneumatic and electronic instrumentation." **J. J. McDonald** (AM '49) was named vice-president, industries department, for the year 1960-61. Mr. McDonald is vice-president and director of engineering, Consolidated Systems Corporation, Monrovia, Calif. Mr. Nichols has served on the following AIEE Committees: Feedback Control Systems (1955-60) and Recording and Controlling Instrumentation (1959-60).

F. H. Nolke (AM '54) recently joined Page Communications Engineers, Inc., as assistant director of the telecommunication directorate. Mr. Nolke came to Page, a subsidiary of Northrop Corporation, from the General Telephone and Electronics Corporation where he was chief engineer for the Midwest operating group.

R. H. Olson (AM '52) has joined the Hughes Aircraft Company's Communications Division in Culver City, Calif., as director of engineering laboratories. Mr. Olson previously was general manager of the Chicago, Ill., Military Products Center of Motorola, Inc.

J. J. Orr (AM '30), has been named director of engineering, United States Rubber Company. Mr. Orr joined the rubber company as an electrical engineer in New York in 1931, and in 1956 became assistant director of engineering. He served on the following AIEE Committees: Industrial

Power Applications (1938-47, chairman 1940-43); Industry Division (1947-51, chairman 1948-50); and Award of Institute Prizes (1948-52, chairman 1950-52).

E. B. Paxton (AM '22, F '54, Member for Life), retired consultant for industry standards, General Electric Company, Schenectady, N. Y., has been presented with a citation from AIEE President C. H. Linder on Mr. Paxton's retirement from the AIEE Standards Committee after 29 years of continuous service on the committee, with 2 years as its chairman. Mr. Paxton served during 1931-60, chairman 1950-52. In his reply, addressed to J. H. Foote, former AIEE president, Mr. Paxton stated: "I am deeply appreciative of the thoughtfulness of you and members of the Standards Committee for this token of regard. The work of the Standards Committee and the pleasant associations I have had with the many fine men who have been fellow members over the years have been of much satisfaction to me. Receipt of the citation is a culminating pleasure and I cherish it greatly."

David Sarnoff (M '23, F '51, Member for Life), chairman of the board of the Radio Corporation of America, has been awarded one of the first annual Eastman Achievement Awards presented by the Eastman School of New York City in recognition of his outstanding contribution to the progress of the electronics industry as well as to the progress and economy of this country.

E. E. Schmidt (AM '45) of Springfield, Ill., formerly substation engineer for the Central Illinois Public Service Company, has been assigned as electrical engineer.

R. G. Slauer (AM '41, M '48), manager of engineering for Sylvania Electric Products Inc., Wheeling, W. Va., has been elected president of the Illuminating Engineering Society, New York, N. Y. He is presently completing a 2-year term as vice-president of the society. **J. D. Mitchell, Jr.** (AM '40, M '54), region engineer, Southeastern Region, Lamp Division, Westinghouse Electric Corporation, Chamblee, Ga., was elected general secretary. **R. L. Zahour** (AM '53, M '55), manager of lamp applications, Westinghouse Lamp Division of Westinghouse Electric Corporation, Bloomfield, N. J., was elected vice-president of the Northeastern Region. Mr. Zahour has served on the AIEE Production and Application of Light Committee (1955-60).

A. H. Sonnenschein (AM '51, M '58) has been appointed assistant to the president of Polarad Electronics Corporation, Long Island City, N. Y. Mr. Sonnenschein, formerly corporate director of planning, will also retain the duties of the latter position.

D. J. Veith (AM '48) has been appointed an engineer in the Plant Engineering Division of Argonne National Laboratory, Argonne, Ill. He will work on electrical design for the Experimental Breeder Reactor-II now under construction at Argonne's Idaho Falls, Idaho, site. Before his Argonne appointment, Mr. Veith held the position of staff engineer at Warren & Van Praag, Inc., Decatur, Ill.

K. R. Wendt (M '52) has been appointed executive vice-president of Colorado Research Corporation, Broomfield, Colo. Mr. Wendt joined Colorado Research in January as manager of the research department.

L. T. Williams (AM '58), who has directed Westinghouse Electric International Company's manufacturing and repair plant at San Francisco in Venezuela since its opening in November 1958, has been assigned to the New York headquarters of Westinghouse International.

D. G. Wilson (AM '40, M '49) has been named vice-president—research of P. R. Mallory & Company Inc., Indianapolis, Ind. In his new post, Dr. Wilson will supervise Mallory's Electrophysical Laboratories, Chemical Laboratories, and Materials Laboratories, and co-ordinate Mallory engineering and research activities throughout the country. In addition to expanding an applied research program, he will establish additional research centers. Dr. Wilson was previously an assistant vice-president of the Stromberg-Carlson Division, General Dynamics Corporation. He has served on the following AIEE Committees: Electronics (1949-60, chairman 1957-59), Science and Electronics Division (1957-60), Education (1958-60), Registration of Engineers (1958-60), and Research (1958-60).

T. T. Witkowski (AM '47, M '54) and **J. T. Underhill** (AM '52) have been appointed director of long-range planning and operations manager, respectively. Mr. Witkowski, former chief engineer, has also been named assistant to the executive vice-president and will be responsible for planning and programming the future of the rapidly growing electronics corporation. Mr. Underhill will also report to the executive vice-president, and as operations manager will be responsible for direct line operations management of the engineering department and for performance on all engineering projects.

OBITUARIES

Edwin Havens Atwood (AM '14, Member for Life), retired Socony Mobil engineer, died recently at the age of 75. Mr. Atwood was born May 17, 1885, in Fannettsburg, Pa. He studied electrical engineering at Cornell University from which he graduated in 1911. In 1912, he joined the Vacuum Oil Company, Olean, N. Y., as the company's first refinery engineer. Mr. Atwood was assigned to the construction of the refinery at Port Jerome, France, in 1929, and remained in Europe as advisory engineer to Socony Vacuum's five European refineries until World War II. In 1940, he was made superintendent of engineering at Socony Vacuum's Paulsboro, N. J., refinery, a job he held until his retirement in 1950.

James Oscar Bewley, Jr. (M '49), a General Elecrtic Company engineer, died recently. He was born October 2, 1911, in New Market, Tenn., and studied at the University of Tennessee from which he received the B.S. degree in electrical engineering in 1934. During 1930-34, he was a student engineer with the East Tennessee Light & Power Company, and for the next 3 years worked as results engineer, operator and load dispatcher, and plant engineer. Mr. Bewley was employed by the Foreign Exploitation Division of the Gulf Oil Company in 1937-41 in Maracaibo, Venezuela, on power plant engineering, line construction, and field operations. In 1941-42, he was associated with the Aluminum Company of America as a construction engineer. His work with General Electric began in 1942 as a field engineer in charge of installations of large apparatus and correction of faulty operation of existing large apparatus. He was also assigned to application engineering, assigned to the engineering study of industrial plants and mines, and recommending proper equipment to perform the required function. Mr. Bewley was a past chairman of the Virginia Mountain Section, AIEE.

Orris Kendall Buck (AM '20, M '31, Member for Life), manager of commercial and industrial sales, Los Angeles Department of Water and Power, Los Angeles, Calif., died on July 1. He was born June 1, 1898, in Spencer, Iowa. During 1917-18, he worked for the Seattle Construction and Drydock Company, U. S. Navy Yard, Bremerton, Wash. For the following 3 years, he was employed on operating, drafting, and maintenance at the White River Generating Station of the Puget Sound & Light Company, Seattle, Wash. In 1922, he became a draftsman for the Bureau of Power and Light, Los Angeles. Mr. Buck was advanced to junior electrical engineer in 1924, and to power salesman in 1925. Mr. Buck served on the AIEE Domestic and Commercial Applications Committee (1948-59).

Rudolf August Karl Fleischmann (AM '52, M '58), chief engineer, Eastern Specialty Company, Philadelphia, Pa., died September 6. He was born April 30, 1905, in Munich, Germany. Mr. Fleischmann was employed by the Eastern Specialty Company in 1936. As chief engineer, he was in responsible charge of all electrical and mechanical design.

Arthur Percy Morris Fleming (M '14, F '34, Member for Life), whose research in electronics contributed to the development of radar, died recently at his home near Shanklin on the Isle of Wight in England. He was born January 16, 1881, in Newport, Isle of Wight, and received a technical education at Finsbury Technical College, London, from which he received a diploma in electrical engineering. In 1900, he was employed by the Westinghouse Electric & Manufacturing Company in Pittsburgh, Pa., and 2 years later, went to work for the Metropolitan-Vickers Electrical Company, formerly the British Westinghouse Company, in Traf-

(*Continued on p. 945*)

AIEE Section and Student Branch Meetings 1959-1960

Table I. Section Membership, August 1960; Section Meetings During Year Ending April 30, 1960

Section	AIEE Members August 1960	Number of Meetings	Total Number of Meetings
Akron	262	7	
Groups: Industrial Application		2	
Power		2	
Joint Meeting: Power and Canton Section Power Group		1	12
Alabama	387	12	
Groups: Communications		3	
Power		5	
Subsection: Montgomery		10	30
Arizona	334	14	
Groups: Communications & Electronics		3	
Computer		3	
Industrial		6	
Power		3	
Joint Meetings: Computer & Industrial		1	
Industrial & Power		1	31
Arkansas	167	9	
Subsection: Northwest Arkansas		8	
Joint Meeting: Section & Northwest Arkansas Subsection		1	18
Arrowhead	81	9	
Groups: Communications Discussion		1	
Mesaba Range Industrial Discussion		9	
Power Discussion		3	22
Baton Rouge	107	7	
Group: Technical		4	11
Beaumont	136	11	
Group: Technical		2	
Subsection: Lake Charles		7	
Joint Meeting: Section & Lake Charles Subsection		1	21
Boston	1,313	9	
Groups: Basic Science		3	
Computer		2	
Electronics & Communications		3	
Engineering Management		2	
Industrial Systems		3	
Instrumentation		2	
Nucleonics		1	
Utility Systems		5	30
Canton	115	7	
Groups: Communications & Electronics		1	
Power Discussion		1	9
Central Florida	239		
Central Illinois	247	10	
Groups: Springfield Technical		5	
Technical		4	19
Central Indiana	441	12	
Subsections: Bloomington		7	
Evansville		7	
Joint Meeting: Section & Evansville Subsection		1	27
Chicago	2,260	3	
Groups: Basic Science		2	
Communications		2	
Electronics		12	
Industrial		3	
Power		3	
Student Activities		3	
Young Engineers		2	
Joint Meetings: Basic Science & Power		2	
Communications & Industrial		2	
Communications & Power		3	
Electronics & Industrial		2	39
Cincinnati	429	9	9
Cleveland	1,191	8	
Groups: Analog Computer & Control		5	
Basic Science		4	
Digital Computer		5	
Electronics, Communications & Instrumentation		5	
Electrical Installations		6	
Management		4	
Motors & Control		6	
Power Generation & Distribution		4	
Joint Meeting: Basic Science & Electronics, Communications & Instrumentation		1	48
Columbus	340	11	
Groups: Feedback Control		1	
Industrial & Utility Power Systems		6	
Management Discussion		1	
Subsections: Newark		6	
Zanesville		12	
Joint Meetings: Chillicothe & Scioto Valley Subsections		8	45
Connecticut	967	7	
Groups: Communications		2	
Electric Power Generation, Transm., Distr.		3	
Electrical Measurements & Controls		2	
Industrial Electronics		2	
Industrial Power Applications		4	
Management		2	
Subsection: New London		9	
Joint Meeting: Section & New London Subsection		1	32
Corpus Christi	124	10	
Group: Technical		1	
Subsection: Victoria-Port Lavaca		9	
Joint Meeting: Section & Victoria-Port Lavaca		1	21
Dayton	344	3	
Groups: Computer		2	
Electronics & Communications		2	
Industrial Control		2	
Instrumentation		2	
Power		2	
Rotating Machinery		3	
Joint Meeting: Motors & Control Group & Lima Section		1	17
Delaware Bay	190	12	
Groups: Electronics		6	
Power Discussion		5	23
Denver	621	9	
Groups: Aeronautical		5	
Communications & Electronics		5	
Equipment		5	
Power Systems		4	
Subsection: Black Hills		5	33
East Tennessee	528	13	
Groups: Chattanooga		7	
Tullahoma Instrumentation		1	
Subsections: Huntsville		5	
Muscle Shoals		7	
Tullahoma		7	
Upper East Tennessee		4	
Joint Meeting: Section & Oak Ridge Section		1	45
El Paso	145	12	12
Erie	214	8	
Groups: Basic Sciences		2	
Computer		1	
Management		2	13
Florida West Coast	283	6	
Groups: Computer		1	
Distribution		1	
Electric Utility		1	
Communications Discussion of Central Florida Subsection		2	
Power Distribution of Central Florida Subsection		7	
Subsection: Central Florida		7	
Joint Meeting: Communications & Power		1	26
Fort Wayne	200	9	
Group: Rotating Machinery Discussion		2	
Subsection: Marion		9	20
Georgia	457	9	
Subsection: Rome		7	16
Gulf Coast	181	11	
Subsection: Panama City		8	19
Hamilton	223	13	
Subsections: Guelph		6	
London		6	
Joint Meeting: Section & Guelph, London Subsections, Toronto Section		1	26
Hawaii	109	11	
Group: Technical		6	17
Houston	461	9	
Groups: Industrial Applications		4	
Power		3	
Wire Communications		1	
Subsection: Freeport		7	24
Hudson Valley	293		
Idaho	104	13	
Group: Southern Idaho Science & Electronics		4	
Subsection: Southern Idaho		9	26
Illinois Valley	105	11	
Groups: Electronics		1	
Power		5	17
Iowa	202	9	
Group: Power		1	
Subsection: Siouxland		4	14
Iowa-Illinois	202	7	
Group: Technical		2	
Subsection: Cedar Valley		8	
Joint Meeting: Section & Cedar Valley Subsection		1	18
Ithaca	364	4	
Subsection: Binghamton Area		6	
Joint Meetings: Section & Binghamton Area Subsection		2	12
Jacksonville	156	10	
Group: Technical		6	16
Johnstown	93	12	
Group: Altoona Technical		1	13
Kansas City	436	11	
Groups: Industrial Power & Petroleum		2	
Power Generation, Transmission & Distribution		3	16
Lehigh Valley	511	11	
Groups: Allentown Technical		8	
Bethlehem Technical		3	
Easton Technical		2	
Hazleton Technical		3	
Reading Technical		5	
Scranton Technical		6	
Wilkes-Barre Technical		3	
Williamsport Technical		2	43
Lima	150	8	
Groups: Aeronautical Discussion		3	
Feedback Controls		3	
Motor & Controls Discussion		3	
Joint Meeting: Motor & Controls & Dayton Section		1	18
Los Angeles	3,024	7	
Groups: Aero/Space		5	
Basic Sciences		5	
Communications		14	
Electronics		6	
Industry & Construction		4	
Magnetics		5	
Management		1	
Power		3	
Subsections: Boulder City		5	
Channel Counties		1	
Orange County		7	
Riverside-San Bernardino		8	

Section	AIEE Members August 1960	Number of Meetings	Total Number of Meetings
Joint Meetings: Basic Sciences & Management		1	
Section & Aero/Space		1	73
Louisville	241	8	
Groups: Communications, Science, Electronics		11	
Power & Industry		1	
Subsection: Lexington		9	29
Lynn	309	12	
Groups: Illumination		1	
Instrumentation		1	
Power		1	
Science & Electronics		2	
Subsection: Merrimack Valley		7	
Joint Meetings: Section & Boston Section		2	26
Madison	105	8	8
Maine	120	8	
Groups: Androscoggin Valley		1	
Augusta Power		7	
Portland Power		4	20
Mansfield	123	8	8
Maryland	955	9	
Groups: Aberdeen Area		1	
Aero-Space		5	
Automatic Controls		6	
Communications		3	
Industrial Electronics		2	
Management		2	
Power		4	
Subsection: Eastern Shore		8	40
Memphis	154	8	
Group: Transmission & Distribution		4	
Subsection: Jackson		6	18
Mexico	180	17	
Group: Technical		6	23
Miami	327	12	
Group: Communications		1	
Subsection: Palm Beach		10	23
Michigan	1,108	6	
Groups: Communications		2	
Industry		2	
Power		7	
Professional Development		5	
Science & Electronics		2	
Joint Meetings: Communications, Power with Science & Electronics		1	
Section with Communications, Industry, Power, Science & Electronics		1	26
Middle Tennessee	76	6	
Groups: Computer		2	
Instruments & Measurements		3	
Power System Engineering		3	
Joint Meeting: Section & Oak Ridge Section		1	15
Milwaukee	986	9	
Groups: Basic Science		2	
Computers		4	
Electric Machinery		3	
Electronics		2	
Power Application & Control		2	
Transmission & Distribution		4	
Joint Meetings: Section & Racine-Kenosha Subsection Electronics, Power Application & Control		1	28
Minnesota	523	7	
Groups: Aeronautics		1	
Industry		1	
Science & Electronics		3	
Subsection: Red River Valley		9	21
Mississippi	108	9	
Groups: Communications		10	
Power		7	26
Montana	124	3	
Group: Technical Group of Butte Subsection		3	
Subsection: Billings		6	
Butte		6	
Helena		7	
Joint Meeting: Section & Butte Subsection		1	26
Montreal	606	12	
Group: Technical Discussion		5	
Subsection: Quebec		6	23
Nashville	106	7	
Groups: Power		1	
Relay		1	9
Nebraska	263	11	
Groups: Applications & Industry		4	
Communications & Electronics		6	
General Technical		1	
Power Apparatus & Systems		10	32
New Hampshire	183	10	
Group: Technical		4	14
New Orleans	297	10	
Groups: Automation		5	
Basic Science		1	16
New York	5,822	1	
Groups: Basic Science		2	
Communications		10	
Illumination		5	
Instrumentation		3	
Land		3	
Marine		5	
Power & Industrial		13	
Subsections: Hudson Valley		5	
New Jersey		8	
Joint Meetings: Section & Communications		1	
New Jersey Div., Power & Industrial		1	
Communications, Power & Industrial		1	
Communications, Power & Industrial Illumination, Basic Science & Section		1	59
Niagara Frontier	405	5	
Group: Technical		14	
Joint Meeting: Section & Niagara International Section		1	20
Niagara International	152	11	
Joint Meeting: Section & Niagara Frontier Section		1	12
North Carolina	602	2	
Groups: Charlotte Communications		4	
Charlotte Industrial Power & Control		10	
Charlotte Substation, Transmission & Distribution		6	
Subsections: Charlotte		9	
Eastern North Carolina		10	
Mid-State		8	
Western North Carolina		7	56
North Texas	790	8	
Groups: Aircraft		5	
Industrial		1	
Power Generation & Rotating Machinery		3	
Relays, Protective Devices, & Carrier Current		4	
Substations, Distribution, Switchgear & Transformers		2	
System Engineering & Transmission		2	
Subsections: Central Texas		8	
Fort Worth		4	
West Central Texas		8	
Joint Meetings: Section & Fort Worth Subsection		1	
Section, Dallas & Fort Worth Subsections		1	
Aircraft & Fort Worth Subsection		1	
Substations & System Engineering		1	49
Northeastern Michigan	142	12	12
Northeastern Wisconsin	121	9	
Group: Technical		3	12
Northern New Mexico	204	4	
Subsection: Los Alamos-Santa Fe		8	12
Oak Ridge	70	12	
Group: Technical		3	
Joint Meeting: Section & East Tennessee Section		1	16
Ohio Valley	71	2	
Joint Meetings: Chillicothe & Scioto Valley Subsections		8	10
Oklahoma City	212	9	
Groups: Communications & Electronics		6	
Industrial Practices		4	
Management		2	
Power Systems		5	
Professional Development		4	
Shawnee		1	31
Ottawa	124	10	
Group: Power		3	13
Panhandle Plains	145	9	9
Philadelphia	2,242	10	
Groups: Aircraft		4	
Basic Science		2	
Communications		6	
Computer Discussion		6	
Electronics Discussion		3	
General Technical		1	
Industrial Practices Discussion		4	
Management		3	
Measurements & Controls		1	
Power Systems		3	
Subsection: Atlantic City Div.		9	
Joint Meetings: Industrial Practices & Measurements		1	
Computer, Power Systems, Measurements		1	54
Pittsburgh	1,669	18	
Subsections: Centre County		8	
Upper Monongahela		4	30
Pittsfield	388	14	
Group: Technical		2	
Subsection: Vermont		9	25
Portland	531	19	
Groups: Communications		1	
Industrial		3	
Power		2	
Research & Basic Science		1	
Technical		8	
Subsections: Eugene		4	
Medford		7	45
Providence	270	12	
Groups: Electronics		3	
Power		3	
Subsection: Southeastern Massachusetts		1	19
Richland	134	8	
Groups: Control & Instrumentation		1	
Power Generation		1	
Technical		1	
Subsection: Walla Walla		5	
Joint Meeting: Section & Walla Walla Subsection		1	17
Ridgway	66	8	8
Rochester	338	16	
Groups: Communications & Electronics		2	
Power & Industrial		1	19
Rock River Valley	147	6	6
Sacramento	210	8	
Groups: Electronics		3	
Transmission & Distribution		2	
Subsection: San Joaquin		8	21
St. Louis	823	11	
Groups: Industrial Apparatus Discussion		8	
Management Development		2	
Power Practices Discussion		7	
Subsection: Eastern Division		4	
Joint Meeting: Industrial Apparatus & Power Practices		1	33
St. Maurice Valley	49	8	8
San Diego	338	10	
Groups: Aircraft & Missile		4	
Electronics		5	

Section	AIEE Members August 1960	Number of Meetings	Total Number of Meetings
Management		9	
Utility		9	
Joint Meetings: Aircraft & Missile, Electronics		2	39
San Francisco	1,915	12	
Groups: Communications		4	
General Applications		4	
Industrial		5	
Instrumentation		2	
Power		5	
Science & Electronics		4	
Subsections: Fresno		8	
Reno		6	
Santa Clara Valley		9	
Shasta		8	
Joint Meetings: General Applications, Power, Industrial		2	
General Applications & Santa Clara Valley		1	
Industrial & Instrumentation		1	
Science & Electronics, Santa Clara Valley		1	69
Savannah	57	7	
Group: City Electrical Code		1	8
Schenectady	846	12	
Groups: Albany-Troy		6	
Silicon Controlled Rectifier		3	
Technical Group of Adirondack Subsection		3	
Subsection: Adirondack		4	
Joint Meeting: Section with Niagara Frontier, Rochester, Syracuse Sec.		1	29
Seattle	918	5	
Groups: Aircraft		8	
Basic Sciences		4	
Feedback Control		3	
Industrial		2	
Management		9	
Power		7	
Subsections: Alaska		6	
Tacoma		9	
Joint Meetings: Section & Aircraft		1	
Section, Feedback Control & Industrial		1	
Section & Tacoma Subsection		1	56
Sharon	248	13	13
Shreveport	176	9	
Groups: Management		2	
Relay & Control		2	
Transmission		1	
Subsection: Monroe		5	
Joint Meetings: Section & Monroe Subsection		2	21
South Bend	129	6	
Groups: Basic Science		2	
Domestic Uses		2	
Electronics		5	
Industrial Power		1	
Motors & Control		3	
Power Distribution		1	
Solid State Devices		4	24
South Carolina	247	2	
Subsections: Central Savannah River		8	
Charleston		9	
Columbia		10	
Piedmont		9	38
South Texas	144	14	
Group: Technical		7	21
Southern Arizona	91	7	
Groups: Communications & Electronics		1	
Industrial		1	9
Spokane	214	11	
Groups: Applications & Industry		5	
Communications & Electronics		6	
Management		8	
Power, Transmission & Distribution		3	
Subsection: Wenatchee		9	
Joint Meeting: Section & Wenatchee Subsection		1	43
Springfield	131	11	
Group: Technical		3	14
Susquehanna	147	9	9
Syracuse	506	7	
Groups: Industrial		2	
Power		5	
Subsection: St. Lawrence International		7	21
Toledo	190	11	
Groups: Electronics		3	
Industrial Practices		2	
Power		1	17
Toronto	737	13	
Groups: Communications		5	
Industrial		8	
Toronto Supper Club		10	
Joint Meeting: Section & Hamilton Section		1	37
Tulsa	231	10	
Groups: Aeronautics		3	
Basic Science		1	
Communications		4	
Electronics		1	
Industrial Power		2	
Instruments & Measuring		3	
Safety & Management		2	26
Utah	168	3	
Group: Technical		6	9
Vancouver	307	19	
Groups: Electronics		5	
Industrial		6	
Power Discussion		7	37
Vermont	58	1	1
Victoria	85	7	
Groups: Relay & Protection		4	
Stations		2	13
Virginia	371	1	
Subsections: Blue Ridge		6	
Hampton Roads		9	
Richmond		7	23
Virginia Mountain	267	7	7
Washington	1,113	11	
Groups: Meetings & Papers		3	
Technical		6	20
West Michigan	133	9	9
West Virginia	139	8	8
Wichita	192	19	19
Worcester	134	7	
Groups: Insulated Conductors		3	
Transmission & Distribution		2	12
	51,589		2,633

Total Sections, 116
Total Technical Groups, 260
Total Subsections, 78

Table II. Branch Meetings Held During Year Ending April 30, 1960

Branches	Number of Meetings
Air Force Institute of Technology	7
*Akron, University of	5
*Alabama, University of	12
*Alaska, University of	10
*Alberta, University of	6
Arizona State University	2
*Arizona, University of	6
*Arkansas, University of	6
Auburn University	13
Bradford Durfee College of Technology	9
Bradley University	5
Brigham Young University	13
*British Columbia, University of	19
*Brooklyn, Polytechnic Institute of (Day)	26
*Brooklyn, Polytechnic Institute of (Eve.)	4
*Brown University	3
*Bucknell University	11
Buffalo, University of	8
*California Institute of Technology	4
California State Polytechnic College	8
*California, University of	16
*Carnegie Institute of Technology	10
*Case Institute of Technology	9
*Catholic University of America	7
Christian Brothers College	7
*Cincinnati, University of	10
*Clarkson College of Technology	2
*Clemson A & M College	10
*Colorado State University	11
*Colorado, University of	11
*Columbia University	3
*Connecticut, University of	10
*Cooper Union	5
*Cornell University	4
*Dayton, University of	18
*Delaware, University of	14
*Denver, University of	27
*Detroit, University of	14
*Drexel Institute of Technology	4
*Duke University	9
Fenn College	23
*Florida, University of	8
Gannon College	4
*George Washington University	8
Georgia Institute of Technology	10
Houston, University of	10
*Howard University	10
Idaho, University of	9
Illinois Institute of Technology	13
*Illinois, University of	7
Chicago Division	11
*Iowa State University	13
Iowa, State University of	25
*Johns Hopkins University	15
Kansas State University	7
*Kansas, University of	7
Kentucky, University of	9
*Lafayette College	7
Lamar State College of Technology	6
Laval University	8
*Lehigh University	5
*Louisiana Polytechnic Institute	12
*Louisiana State University	5
*Louisville, University of	14
*Maine, University of	10
*Manhattan College	11
*Marquette University	9
*Maryland, University of	9
*Massachusetts Institute of Technology	6
*Massachusetts, University of	10
Merrimack College	5
Miami, University of	1
*Michigan College of Mining & Technology	8
*Michigan State University	3
*Michigan, University of	8
Milwaukee School of Engineering	6
*Minnesota, University of	7
Mississippi State University	12
*Missouri School of Mines & Metallurgy	14
*Missouri, University of	9
*Montana State College	9
*Nebraska, University of	9
*Nevada, University of	9
Newark College of Engineering	6
*New Bedford Institute of Technology	15
*New Hampshire, University of	9
*New Mexico State University of Agriculture, Engineering & Science	12
*New Mexico, University of	8

Branches	Number of Meetings
*New York, College of the City of	18
*New York University (Day)	6
*New York University (Eve.)	6
*North Carolina State College	11
*North Dakota State College	11
*North Dakota, University of	14
*Northeastern University	19
*Northwestern University	34
*Norwich University	7
*Notre Dame, University of	10
*Ohio Northern University	8
*Ohio State University	2
*Ohio University	6
*Oklahoma State University	1
*Oklahoma, University of	8
Oregon State College	12
*Pennsylvania State University	5
*Pennsylvania, University of	11
Pittsburgh, University of	31
Prairie View A & M College	
*Pratt Institute	3
*Princeton University	9
Puerto Rico, University of	1
*Purdue University	7
*Rensselaer Polytechnic Institute	6
*Rhode Island, University of	7
*Rice Institute	6
*Rose Polytechnic Institute	5
*Rutgers University	20
Saint Louis University	4
*San Jose State College	7
*Santa Clara, University of	7
Seattle University	4
*South Carolina, University of	6
South Dakota School of Mines & Technology	9
*South Dakota State College	10
*Southern California, University of	10
*Southern Methodist University	8
Southwestern Louisiana Institute	7
*Stanford University	8
*Stevens Institute of Technology	5
*Swarthmore College	10
*Syracuse University	7
Tennessee Polytechnic Institute	13
Tennessee, University of	12
Texas College of Arts & Industries	7
*Texas, A & M College of	11
*Texas Technological College	8
*Texas, University of	8
Texas Western College	7
*Toledo, University of	15
*Toronto, University of	6
*Tufts University	7
*Tulane University	8
*Union College	5
United States Naval Post Graduate School	12
Utah State University	12
*Utah, University of	2
Valparaiso University	6
Vanderbilt University	12
*Vermont, University of	4
*Villanova University	7
Virginia Military Institute	17
*Virginia Polytechnic Institute	12
*Virginia, University of	7
*Washington State University	8
*Washington University	4
*Washington, University of	21
*Wayne State University	6
West Virginia Institute of Technology	9
West Virginia University	7
Wichita, University of	4
*Wisconsin, University of	9
*Worcester Polytechnic Institute	4
*Wyoming, University of	14
*Yale University	5
*Youngstown University	9

Total Branches 164
*Joint AIEE-IRE Branches 122

(*Continued from p. 941*)

ford Park, Manchester, England. During 1902-06, he was an insulation specialist, and for the following 8 years was a superintendent and chief engineer in the transformer department. In 1914, he became director of research and education. Sir Arthur was a leader in the perfection of methods for manufacturing vacuum high-voltage equipment and thermionic valves, component parts of radar. For his pioneering efforts in the development of submarine-detection equipment, he was awarded the Commander Order of the British Empire during World War I. Sir Arthur was a member of the Ministry of the Labor Advisory Council of the Central Register in 1938 and chairman of the Electrical Engineering Committee of the Central Register of the Ministry of Labor in 1939. He served on the governing body of the Imperial College of Science and Technology, the delegacy of City and Guilds College, the War Cabinet Engineering Advisory Committee, and Lord Hankey's Technical Personnel Committee in 1941. He was a member of the Technical Personnel Committee set up in 1951, the Board of Education Committee on Training of Teachers and Youth Leaders, and the National Advisory Council for Further Education. In 1945, he was knighted for his services to education, and he received honorary degrees from the Universities of Manchester and Liverpool for his work in technical education and research. Sir Arthur served as chairman of the Management Committee, Athlone Fellowships, 1950, and was vice-president of the British Association for Commercial and Industrial Education. He received the Thomas Hawksley Medal of the Institution of Mechanical Engineers in 1937 and the Faraday Medal of the Institution of Electrical Engineers, of which he was president in 1941.

Pierce G. Fredericks (M '29), retired New York electrical engineer, died September 25. He was born January 30, 1889, in Houston, Texas. Mr. Fredericks was retired last year as commercial vice-president of the Federal Pacific Electric Company after almost 50 years' association with the electrical industry.

George Hadley (Affil '53) an electrical designer with the Wigton-Abbott Corporation, Plainfield, N. J., died September 12. He was born July 25, 1924, in Plainfield. Mr. Hadley had been employed by Wigton-Abbott since 1947. He had also served as an engineering operations officer of the Air Installations Office, McGuire Air Force Base, Trenton, N. J.

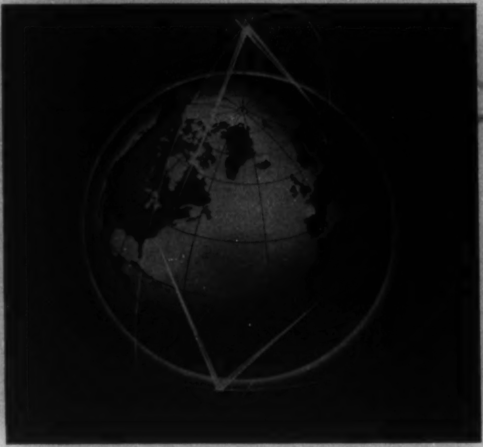
Nicholas Alexander Ivanoff (AM '42), an electrical engineer with Howard, Needles, Tammen & Bergendorf, New York, N. Y., died September 11 at the age of 59. Mr. Ivanoff, who was born in Russia on December 3, 1900, studied electrical engineering at Pratt Institute. During 1922-25, he was employed as an electrical instrument maker for Charles Cory & Son, New York. He worked as an electrical inspector, assistant engineer, and power dispatcher in 1927-41 for the Delaware, Lackawanna, & Western Railroad Company, Hoboken, N. J. In 1941, he became an electrical designer and detailer for the New York Central Railroad. Mr. Ivanoff also served as a consulting engineer on lighting projects for the New Jersey Turnpike Authority.

Humphrey George Michell (AM '20, M '27, F '49), assistant manager, international operations, Montreal Engineering Company, Ltd., Montreal, Que., Canada, died August 15. He was born October 1, 1894, at Miniota, Man., Canada. In 1920, he received the B.Sc. degree in electrical engineering from the University of Manitoba. He was employed by the Winnipeg Hydro-Electric System, Winnipeg, Man., in 1920, as assistant to the distribution engineer. In 1922, he became distribution engineer of the company, a position he held until 1926, when he became distribution engineer of the Mexican Light & Power Company, Ltd. Mr. Michell became superintendent of distribution of the Mexican company in 1928, and later that year, superintendent of transmission and distribution. In 1932, he became manufacturers' representative for Haefly Static Condensers, Toronto, Ont. Two years later, he became electrical engineer for the Mexico Tramways Company, Mexico City, Mexico. Mr. Michell went to work for the Bolivian Power Company in 1939 as manager, Oruro Division. He became manager of La Paz Division of the company in 1946, and general manager of the company in La Paz in 1947.

Marion Alvin Mulrony (AM '12, M '17, Member for Life), retired engineer, Tacoma, Wash., died recently. He was born April 11, 1887, at Colfax, Wash. In 1910, he became chief engineer and works manager for the Shaw Wireless, Ltd., of Randwick, Sydney, Australia, where he was assigned to the design and manufacture of commercial and special electrical machinery. He designed and manufactured more than 50 500-cycle high-tension wireless transformers and several 500-cycle alternators for wireless work.

Martine F. Schonefeld (AM '38), Fort Wayne Division general superintendent, Indiana & Michigan Electric Company, Fort Wayne, Ind., died recently. He was born March 29, 1902, in Fort Wayne, and received the B.S. degree in electrical engineering in 1925 from Purdue University. A veteran of 35 years of service with the Indiana and Michigan, he joined the company in 1925, then the Indiana Service Corporation, as an engineer. In 1929, he became superintendent of electric distribution, and in 1933, electrical engineer. Mr. Schonefeld was named Fort Wayne Division general superintendent in 1955. He was a registered professional engineer in the State of Indiana and a member of the Fort Wayne Engineer's Club.

OF CURRENT INTEREST

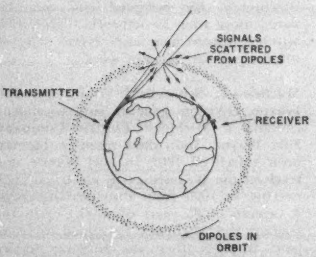


TWO "orbital scatter" belts (one east-west over the equator and one north-south over the poles) will relay radio messages over very long distances in communication system being developed by MIT Lincoln Laboratory. The tiny metallic fibers (dipoles) in the belts will be hundreds of feet apart.

Orbital Scatter Communication For Teletype, Voice, and Television

A NEW and unique method of reliable global communications by millions of minute orbiting particles for teletypewriter, voice, and television was described recently by W. E. Morrow, Jr., of Massachusetts Institute of Technology Lincoln Laboratory in Lexington, Mass., at a meeting of the International Scientific Radio Union in London, England.

Known as orbital scatter, the new technique utilizes the reflective properties of a belt of tiny metallic fibers, or dipoles, about ½ inch long and ⅓ the diameter of a human hair, placed in orbit several thousands of miles above the earth. Radio waves transmitted to the belt will be scattered back to earth where they can be picked up by radio receiving equipment. Transmitting and receiving antennas will be trained on the same spot in the belt. The reflective principle will be similar to that employed in ionospheric and tropospheric radio communications.



TUNED dipoles in orbit will be used for world-wide radio communication in "orbital scatter" system being developed by the MIT Lincoln Laboratory. The dipoles are tiny metallic fibers, thinner than a hair, widely dispersed along an orbit some 40,000 miles in length.

The basic concept of orbital scatter was developed by Mr. Morrow in collaboration with Harold Meyer of the Thompson-Ramo-Wooldridge Corporation, in 1958. Full-scale technical development is being carried on at Lincoln Laboratory where experiments are being prepared to test the feasibility of the technique and to confirm the results of theoretical studies. Orbital scatter can potentially serve both civilian and military purposes.

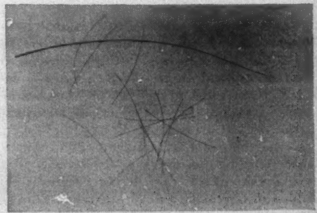
The ever-growing demand for long-distance communications has increased the desirability of using higher radio frequencies where bandwidth is still available. In these higher frequencies, energy is propagated in straight lines and does not follow the curvature of the earth. Since the earth's curvature imposes limitations on the length of line-of-sight communications links, at long distances it is necessary to use reflective or scattering techniques.

The number of exclusive communications circuits between different geographical locations which can be carried simultaneously by a single orbital scatter belt is exceedingly large. The number of circuits between any two locations will be determined by the capacity of the ground radio equipment and the size of the belt. With two such belts, one east-west over the equator and one north-south over the poles, communications can be established between any two points on the earth, and can link widely separated nations and territories. This technique offers promise of very high system reliability, since all of the active radio equipment is located on the ground and easily accessible for maintenance.

A rocket will be used to place in the desired orbit a cylindrical container into which the small dipoles have been packaged. When the orbit has been attained the container will be ejected from the rocket. A dispensing mechanism will then release the fibers gradually from the container, over a period of 1 day.

It is estimated that within 1 to 2 months the dipoles will spread to form a continuous belt around the earth. In a completed belt, using the example which Mr. Morrow described, it is calculated that the small fibers will be separated on the average by about 1,000 feet.

Orbital scatter appears to offer a number of advantages in long-distance radio communications. With two orbits, only two rockets will be required to provide practically world-wide coverage. The electronic and physical characteristics of the dipole belt will afford a very large num-



CAT'S WHISKER (top) about 2 inches long dwarfs the tiny metallic fibers that will be sown in orbit about the earth to relay radio messages over very long distances, in long-range "orbital scatter" radio communication system being developed by the MIT Lincoln Laboratory.

ber of communications circuits. Since the dipole belt will be relatively stationary in space, transmitting and receiving antennas on the ground can be trained continuously on the same spot in the belt with a movement of only a few degrees per day. This slow motion eliminates the need for high-speed tracking equipment. The lifetime of the belt can be varied from a matter of months to years, depending on the altitude and inclination of the orbit together with the dipole design. As the belt nears the end of its useful life, the dipoles will be dissipated harmlessly in the atmosphere. Belts with a relatively short lifetime are proposed for an initial experiment.

Theoretical studies have indicated that known phenomena such as solar radiation pressure, atmospheric friction, sun and moon gravitation, micrometeorites, magnetic field effects, and the influence of high-energy particles will not produce excessive undesirable changes in the belt.

Computations, prepared on the hypothetical example discussed by Mr. Morrow, have convinced Lincoln scientists that the dipoles in orbit will have negligible adverse effects both on the use of space, and on the various types of astonomical observations; optical, radio, or radar. Discussions with other scientists and scientific groups, including an Ad Hoc Committee of the Space Science Board of the National Academy of Sciences have confirmed this opinion. **EE**

Navy-Air Force Digital Flight Trainer

A new digital flight trainer and research device called UDOFTT (Universal Digital Operational Flight Trainer, Tool) was demonstrated publicly for the first time recently when a "flame-out" emergency was introduced into a simulated Air Force F-100A Super Sabre jet flight by an instructor outside the cockpit.

UDOFTT was developed by Sylvania Electric Products, Inc., a subsidiary of General Telephone & Electronics Corporation, under a $2 million contract with the U. S. Naval Training Device Center, Port Washington, N. Y., a field activity of the Office of Naval Research. The program is under the joint sponsorship of the U. S. Air Force and the Department of the Navy.

When the "flame-out," or engine failure, was introduced into UDOFTT, the pilot of the simulated flight, Navy Commander J. H. Bahlman, cut off all electric circuits while the supersonic jet descended from 15,000 to 7,000 feet, restarted his engine in mid-air, and brought the plane in for a safe landing. Each operation was performed under realistic conditions within UDOFTT's sealed F-100A cockpit.

Rear Admiral Rawson Bennett, Chief of Naval Research, said UDOFTT "is expected to be the forerunner of an entirely new family of training devices."

Henry Lehne, a senior vice-president of Sylvania, said that because of its flexibility and high-speed operation, "the UDOFTT computer system can simulate any vehicle that can be represented by a mathematical formula—including space ships, nuclear submarines, helicopters, hydrofoil craft, and others. With modification, it can simulate several vehicles simultaneously."

With the UDOFTT digital system, complete mathematical representations of the characteristics of the aircraft to be simulated are transferred through punched cards into the computer's magnetic core memories. Thereafter, manipulation of the plane's controls provides new information to the computer which then computes the equations of motion and activates the instruments in the cockpit to correspond to the plane's "actions."

UDOFTT may be changed to simulation of another vehicle type simply through processing punched cards on that vehicle into the computer. Individual special-purpose analog computers, used for flight simulation in recent years, are restricted —without substantial modification—to simulation of a single aircraft.

UDOFTT, which operates at a rate of more than 200,000 operations per second, is the result of intensive research by the Navy and Air Force to develop a flexible computer system with "real-time" capability—the ability to respond instantaneously to the commands of a student pilot within the cockpit or an instructor at an external control panel.

Admiral Bennett said future uses of UDOFTT, in addition to training and simulation, will include research in the areas of engineering techniques, mathematical techniques, and "human engineering" or psychology—such as pilot reaction in coping with abnormal circumstances.

UDOFTT utilizes a cockpit duplicating that of the vehicle it is to simulate. The cockpit and external instructor panel contain identical instruments, enabling the instructor to make corrections or introduce new conditions during a simulated flight. A Navy F9F-2 Panther jet cockpit is presently included in the system, along with the Air Force F-100A.

UDOFTT was developed by the Data Systems Operations of Sylvania Electronic Systems, a major division of Sylvania, in Needham, Mass., utilizing initial logical design studies of the Moore School of Electrical Engineering, University of Pennsylvania. **EE**

Space Vehicle Unit Protected by Gold Coating

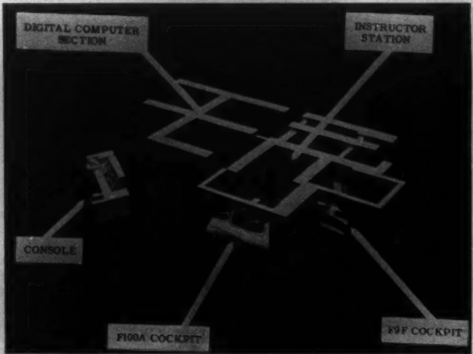
"Steering jets" built for advanced space vehicles will be coated with gold to fight off cosmic bombardment, it was revealed recently.

The jets, called thrust controllers, manufactured by Bendix-Pacific Division of The Bendix Corporation, are being plated with gold because of its reflectivity and density properties—not for glamour.

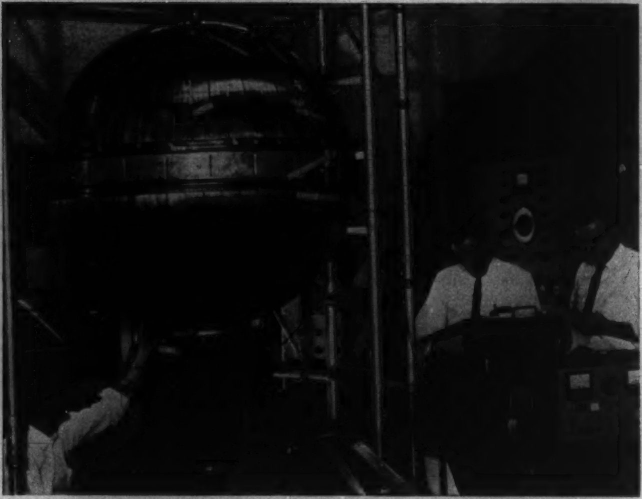
The hand-sized electropneumatic controllers, first developed by the company for the Discoverer satellite series, keep space vehicles from tumbling and spinning in flight by automatically providing opposing thrusts of gas, it was explained.

The 99.8% pure gold plating is 40 millionths of an inch thick. This coating will reflect 95% of all energy radiation which might strike an orbiting vehicle's surface.

During the coating process, the controller is first sprayed with a thin coat of epoxy, a plastic which helps bond the gold to the metal device. Solid gold and the controller are then placed in a near-vacuum chamber, and the gold is heated to 4,712 F. At that temperature, the gold vaporizes and spreads throughout the chamber to plate the controller thoroughly. Later, the unit is baked for 30 minutes in a special oven to complete the coating treatment. **EE**



UDOFTT (Universal Digital Operational Flight Trainer, Tool) is capable of simulating travel conditions of jet aircraft, nuclear submarines, tanks, helicopters, space ships, or any other vehicular system that can be mathematically depicted. It is comprised of five primary sections: (1) Digital Computer Section. Contains the fixed memory, the arithmetic unit, the control unit, and power source. The prime function of the digital computer section is to solve equations of flight using data received from the cockpit-instructor station. The digital computer section, operating on a 5-microsecond basis, instantly reads data to the pilot's instruments—present altitude of aircraft, position, flight conditions, etc. (2) Console. Initiates the program and is used to check out the program. (3) Instructor Station. From this position the instructor monitors flight, inserts problems and emergency conditions. More than 50 emergency conditions can be inserted. The instructor also has a duplicate set of instruments and radio communication with the pilot isolated in the cockpit. This enables the instructor to correct or suggest new techniques to remedy emergency conditions or to help the pilot fly (blind) and vector him in via radio direction finder. (4) Duplicate of Navy F9F-2 Panther jet cockpit. (5) Duplicate of USAF F-100A Super Saber jet cockpit.



Courtesy Philco Corporation

THE balanced and weighted model of the Courier is mounted on the vibration table to test its performance under the conditions which were encountered as the Thor-Able-Star accelerated the payload into orbit around the earth.

Courier Satellite For Global Communications

THE 500-pound Courier satellite now orbiting around the earth was built for the Department of Defense by Philco Corporation at its Western Development Laboratories with the help of approximately 43 principal subcontractors and more than 200 materials suppliers.

The satellite, which circles the earth in a little less than 2 hours, functions primarily as a "delayed repeater," recording messages from a ground station for later retransmission while passing over another ground station.

The effective instantaneous rate of data transmission of Courier is 55,000 bits per second of incoming traffic, plus the same amount simultaneously outgoing.

Microwave Communications Subsystem: The microwave communications subsystem is comprised of four microwave FM transmitters, four microwave receivers, a baseband combiner, five data-storage tape recorders, microwave antennas, and diplexers. Two microwave antennas with hemispherical radiation patterns are located on the equatorial band of the satellite. Two independent transistorized FM receivers are connected to each antenna through the diplexers and r-f cables. The receiver noise figure is less than 12 db. Each receiver weighs 6.4 pounds and requires 3.3 watts of primary power. The video baseband outputs of the four receivers are combined in the diversity combiner. The signal-to-noise ratio of each receiver output is measured, and the outputs are combined proportionally to their signal-to-noise ratios.

To avoid undue complexity in switching, the transmitters are operated in pairs, with each transmitter of each pair connected to one of the microwave antennas.

The transmitters use solid-state active circuit elements except for the final power amplifier tube. Frequency stability over the environmental temperature range is assured by the use of a crystal-controlled reference oscillator circuit which operates an electromechanical frequency control system.

Each transmitter weighs 26 pounds and requires less than 80 watts input for an r-f power input of 7 watts.

Five tape recorders are used in the Courier satellite. Four of the recorders are designed to store teletypewriter digital communications data. The fifth recorder will be used to test the system capability with analog or voice information. Data can be read into, or out of each recorder for 5 minutes.

The tape recorders were developed for Philco by Consolidated Electrodynamics Corporation of California.

Telemetry Subsystem: A PAM/FM/FM telemetry system has been provided to evaluate the performance and environmental condition of the Courier satellite. An all-transistorized telemetry generator has been developed by Philco to commutate 26 system parameters, such as equipment temperatures and equipment performance, such as receiver signal-to-noise ratios, transmitter power outputs, and power system voltage and current.

The various telemetry sensors, the telemetry generator and redundant 1.5-watt FM transmitters comprise the telemetry subsystem. All active circuit elements in this subsystem are solid-state devices.

The telemetry transmitter power is radiated from four whip antennas located on the equatorial band of the satellite. A vhf diplexer is included to permit simultaneous vhf transmitter and vhf receiver operation.

Command Subsystem: The command subsystem serves as the "switchboard" for the microwave communications and telemetry subsystems, as a clock to synchronize certain satellite functions, and in addition has the "repairman" function of switching between certain of the equipment in the satellite. The command subsystem is comprised of redundant vhf receivers and a command decoder which performs many logical operations on the command data to ensure that erroneous commands are not accepted.

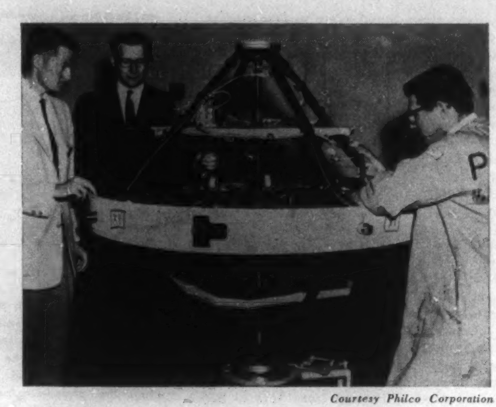
Commands are delivered to the decoder from two all-transistorized crystal-controlled FM command receivers.

VHF Beacon: The Courier satellite has

Courtesy International Telephone and Telegraph Corp.

AS soldier (foreground) prepares teletypewriter message for eventual transmission to orbiting satellite, other men at the control van equipment, developed by International Telephone and Telegraph Corporation and the U.S. Army Signal Corps, monitor complex electronic apparatus capable of loading Courier with 400,000 words every 5 minutes—and taking on the same amount—each time the satellite hurtles over the horizon and breaks into radio view.

JOHN BURT of the U.S. Army Signal Research and Development Laboratory of Ft. Monmouth, N.J. (*left*), and Gerald Moore, Philco satellite project manager (*center*), inspect a receiver and a transmitter mounted on the inner structure platforms of the Courier communication satellite. Ronald Weathers, Philco technician, attaches cable. Various pieces of electronic equipment are mounted on both sides of the three platforms.

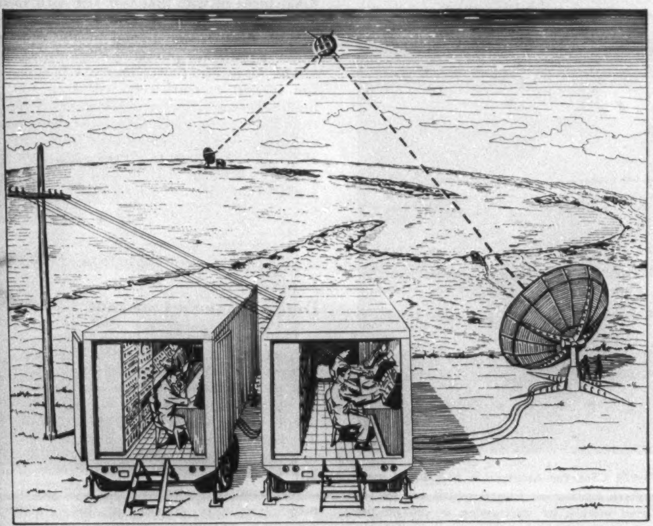


Courtesy Philco Corporation

a 50-milliwatt transistorized vhf transmitter subsystem. The beacon is capable of providing tracking signals to the Minitrack stations to assist in determining the orbital parameters of the Courier.

Primary Power Subsystem: Approximately 20,000 silicon solar cells are fastened to the surface of the Courier satellite. These semiconductors convert solar energy into electric power to operate the electronic equipment within the satellite. Solar cells are soldered into "shingles" comprised of seven cells each. Twelve shingles are connected in series and attached by adhesives to a curved Fiberglas base, or array, which is in turn fastened to a hemispherical cover of the satellite. These arrays are connected in parallel to form the complete solar battery.

Two separate and independent sets of solar arrays are provided on the Courier. Each one charges a nickel cadmium storage battery which permits higher peak power loads than the solar arrays can supply. Unlike several of the early short-lived satellites which relied on storage batteries alone, the Courier is capable of operating for periods measured in years rather than days or weeks, because of the nature of its power system. **EE**



Courtesy International Telephone and Telegraph Corp.

POWER and control vans at Fort Monmouth, N.J., and Salinas, Puerto Rico, send and receive 400,000 words every 5 minutes, each time Courier circles the earth once every hour and 50 minutes. Commands issued by the control center direct the satellite to boost its power and energize transmitting equipment for communicating with the radio van. The artist's conception shows the two stations—in northeastern United States and on the eastern end of Puerto Rico, along with the antennas which send signals reaching to the satellite.

Future Meetings of Other Societies

National Warm Air Heating and Air Conditioning Association, Annual Convention, Nov. 14-17, Statler-Hilton Hotel, Cleveland, Ohio. Air-Conditioning and Refrigeration Institute, 1346 Connecticut Ave., N.W., Washington 6, D.C.

NEMA, Annual Meeting, Nov. 14-18, Traymore Hotel, Atlantic City, N.J., National Electrical Manufacturers Association, 155 E. 44th St., New York 17, N.Y.

Symposium on Engineering Applications of Probability and Random Function Theory, Nov. 15-16, Purdue University, Lafayette, Ind. J. L. Bogdanoff, Division of Engineering Science, Same.

MAECON, Mid-America Electronics Conference, Nov. 15-16, Hotel Muehlebach, Kansas City, Mo. L. R. Crissman, Trans World Airlines, 10 Richards Rd., Kansas City, Mo.

BRI, Fall Conferences, Nov. 15-17, Shoreham Hotel, Washington, D.C. Building Research Institute, Div. of Engineering and Industrial Research, National Academy of Sciences, 2101 Constitution Ave., Washington 25, D.C.

ASME, Winter Annual Meeting, Nov. 27-Dec. 2, Statler Hilton Hotel, New York, N.Y. L. S. Dennegar, The American Society of Mechanical Engineers, 29 W. 39th St., New York 18, N.Y.

24th National Exposition of Power and Mechanical Engineering, Nov. 28-Dec. 2, New York Coliseum. Same, 480 Lexington Ave., New York 17, N.Y.

AIME, Electric Furnace Conference, Nov. 30-Dec. 2, Morrison Hotel, Chicago, Ill. American Institute of Mining, Metallurgical, and Petroleum Engineers, Inc., 29 W. 39th St., New York 18, N.Y.

IRE, Professional Group on Vehicular Communications, 11th National Conference, Dec. 1-2, Sheraton Hotel, Philadelphia, Pa., M. T. Speights, P.O. Box 443, Fort Washington, Pa.

EIA, 3rd Conference on Maintainability of Electronic Equipment, Dec. 5-7, Hilton Hotel, San Antonio, Texas. J. T. Caffiaux, Electronic Industries Association, Engineering Dept., 11 W. 42nd St., New York 36, N.Y.

Application of Electrical Insulation, 3rd National Conference, Dec. 5-8, Conrad Hilton Hotel, Chicago, Ill., F. C. Osterland, Motor & Generator Department, Allis-Chalmers Manufacturing Co., Milwaukee 1, Wis.

Industrial Building Exposition and Congress, Dec. 12-15, New York Coliseum, Clapp & Poliak, Inc., 341 Madison Ave., New York 17, N.Y.

Atomic Industry Exhibition, Dec. 12-15, California Masonic Memorial Temple, San Francisco, Calif. D. J. Scherer, Atomic Industrial Forum, 3 E. 54th St., New York 22, N.Y.

Overseas

Symposium on Experimental and Test Reactors, Nov. 28-Dec. 2, Vienna, Austria. International Atomic Energy Agency, 11 Kartner Ring, Vienna 1, Austria.

INVENTOR of accutron, horologist and physicist Max Hetzel, holds transistorized circuit of Bulova's new Accutron electronic timepiece with jig and readies tuning fork for insertion between tiny coils, each containing 8,000 turns of wire. He started working on Accutron development in Bulova's Switzerland plant 8 years ago. Hetzel is now chief physicist at the company's main plant in Jackson Heights, N.Y.

Transistorized Timepiece "Hums" Instead of "Ticks"

A new sound of time—a "microsonic" hum to replace the centuries-old ticking sound—was introduced recently in a new transistorized timepiece designed to make conventional wrist watches a thing of the past.

The new timepiece, called the "Accutron," looks like a wrist watch, but uses timekeeping principles never used in a wrist watch, according to its inventors, the Bulova Watch Company, Inc.

"The same instrument we can now wear as a personal timepiece on our wrists is orbiting earth as a timing instrument aboard the Explorer VII satellite," said Gen. Omar N. Bradley, Bulova board chairman, who introduced his company's new development. The task of the timer, which weighs 8 ounces and replaces 30 pounds of otherwise necessary equipment, is to turn off the satellite transmitter at a preset time.

"Because of its performance in space and the 3 years of field testing that we have put it through here on earth, we believe," Gen. Bradley said, "that Accutron is more accurate than any conventional wrist watch be it powered by spring or battery, and considerably more reliable in operation."

"Furthermore," he said, "we believe Accutron is the most significant advancement in timekeeping in more than 300 years."

Bulova supports its accuracy claim for the new watch by guaranteeing the Accutron in use to be accurate within 1 minute per month; approximately 10 times more accurate than fine-quality wrist watches.

Gen. Bradley said that Accutron was so unlike a conventional watch that his company has been referring to it as a "microsonic" or electronic timepiece. The new timekeeper has none of the conventional watch components, such as main spring, escapement, winding mechanism, winding and setting stem, balance wheel, and hairspring.

An electromagnetic tuning fork that is powered and controlled by a transistorized electronic circuit replaces the balance wheel and hairspring. It is the tuning fork—vibrating at 360 cycles per second within the Accutron—that gives off the slight "hum" barely audible when the instrument is held close to the ear.

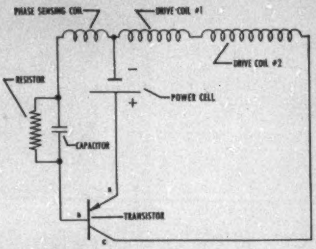
Jewelry stores in 32 market cities throughout the country will start selling the Accutron in mid-November, a company marketing spokesman said. Prices of the Accutron will range from $175 to $2,500, with most of the dozen men's models in the $250 to $400 range. The $2,500 model is in platinum.

The Bulova company originated development of the Accutron some 8 years ago in its Swiss plant. Max Hetzel, a Swiss horologist and electronic engineer who is now Bulova's chief physicist, is the inventor of the electronic timepiece.

Bulova has obtained numerous American and foreign patents on its device.

Microminiaturization and refinement of the electromagnetic and electronic components of the Accutron has been directed for the past 5 years by W. O. Bennett, vice-president of research and engineering for Bulova.

POWER CELL for Accutron is a 1.3-volt mercury cell (shown on finger) which can be replaced merely by unscrewing a cap on the back of the Accutron case. Power cell looks similar to hearing aid batteries, but is specially designed for Accutron's requirements. Replacement power cells will cost $1.50. Recessed handle for setting the hands also is on the back of the case. Accutron shown is one of 12 introduced recently by Bulova Watch Company, Inc.



ELECTRONIC CIRCUIT of the Accutron acts as an on-off switch as it continuously imparts driving pulses through the drive coils to the magnetic cup arrangement on each tine of the tuning fork time standard (not shown). Voltage flows from the power cell to drive coils through switching germanium transistor when the phase-sensing coil "senses" the correct position of the tuning fork during each vibration. Frequency of vibration is maintained at 360 cycles per second. The 1.3-volt mercury power cell delivers 6 millionths of an ampere (0.000006), 8 millionths of a watt (0.000008).

A single component that probably best represents microminiaturization within the device is an index wheel that transposes vibratory motions from the tuning fork to rotary motion to move the hands. This gear is 0.095 inch in diameter (about like a pin head) and 0.0015 inch thick (about one half the diameter of a human hair); yet, it has 300 precisely machined ratchet teeth.

The tiny coils that keep the tuning fork vibrating are ¼ inch long. Each coil has 8,000 turns of wire that is 0.0006 inch in diameter (only about one fifth the diameter of a hair). One pound of this wire would stretch 200 miles.

The Accutron's power source, a button-size 1.3-volt mercury cell, will keep the timepiece running for at least a year. Operation of the device requires about 8 millionths of a watt (equal to 10 billionths of a horsepower). In comparison, the power used by an electric toaster to toast a slice of toast would operate the Accutron for about 250 years. **EE**

Eskimo Village To Have Dial Telephone Exchange

The traditional "mukluk telegraph" of the Arctic—the hand-to-hand and mouth-to-mouth means by which Eskimos have sent their messages for centuries past—will get a modern assist from the new dial telephone exchange of the Trans-Alaska Telephone Company which was scheduled to go into operation at Kotzebue, Alaska, late in October.

Kotzebue will become the northernmost telephone system on the North American continent, according to J. E. Field, president of Trans-Alaska.

The Kotzebue installation, constructed under the supervision of J. V. Ditto, vice-president of Trans-Alaska, will serve about 100 subscribers in this predominantly Eskimo community. These subscribers will include a new hospital built

THIS BUILDING, near the center of Kotzebue, Alaska, will house the community's new dial telephone exchange, built by Stromberg-Carlson Division of General Dynamics Corporation. The Kotzebue exchange, part of the Trans-Alaska Telephone Company, will be the northernmost on the American continents, and, it is believed, the only telephone system north of the Arctic Circle.

by the U. S. Bureau of Indian Affairs to provide medical care for the native population in the area.

This will be a completely modern dial exchange, built by the Stromberg-Carlson Division of General Dynamics Corporation, in Rochester, N. Y. In fact, Kotzebue will receive the first production model of Stromberg-Carlson's new "Compak I" 100-line dial exchange.

There is another innovation that will be enjoyed by Kotzebue telephone subscribers—the telephones that will go into service in the community's trading posts, business establishments, cabins, and homes will be Stromberg-Carlson's line of "Petite" colored phones.

Actually, there is no Eskimo word for telephone, but the fluid and oft-times ingenious Eskimo tongue has solved this problem by coining the word "Okoksoon," meaning, roughly, "to talk into a telephone."

Kotzebue is the second largest Eskimo village in Alaska, with a population of about 1,200, and with about 3,800 living in the area. Natives outnumber all others in the community by a ratio of about 20 to 1. The village is named after Otto von Kotzebue, Russian explorer who was the first European to land in the area, in 1816. Eskimos have lived there for thousands of years, however.

The Kotzebue exchange is just one of a number of new dial telephone exchanges being planned by Trans-Alaska, which recently signed a $1.3 million contract with Stromberg-Carlson for equipment to implement its expansion program. The company, which serves a major portion of the 49th state, has general offices in Anchorage. **EE**

THE NEW "Okoksoon," in Kotzebue, Alaska, is tried out by one of the Eskimo women in the village. It is one of Stromberg-Carlson's "Petite" telephones, selected by Trans-Alaska Telephone Company as standard equipment in the Kotbebue telephone system. One of the reasons for this choice is that the "Petite" has a dial light, making it easy to find and use the telephone during the long Arctic night.

High-Energy Electric Arc Heater

A machine with the potential capability to supply a stream of gas at temperatures as high as 20,000 F and pressures as great as 15,000 psi has been devised by the Westinghouse Electric Corporation. The machine, an electric arc heater, can operate for sustained periods of time and at an extremely low level of gas contamination.

The arc heater has immediate application in a wind tunnel for missile testing. Also, it holds promise as a chemical synthesizer and as a furnace for processing metals with ultrahigh melting points. A prototype model of the machine has been operated at a power input of 1,700 kw, but a high of 30,000 kw is planned by the company.

Dr. J. A. Hutcheson, vice-president in charge of engineering for Westinghouse, credited the new arc heater with being the first to operate continuously and at a low level of gas contamination.

"The temperature into the nozzle has been maintained at 10,000 degrees—approximately as hot as the surface of the sun," Dr. Hutcheson said. "In addition, flow from the nozzle of the unit has reached a sonic velocity of 3,400 miles per hour. Velocities over ten times the speed of sound can be expected when the gases are expanded with a hypersonic exhaust nozzle.

"Applying these characteristics to a wind tunnel will help duplicate the extreme conditions met by missiles and other space craft of the future upon reentry into the earth's atmosphere.

"As a chemical synthesizer, the machine will supply the high temperatures necessary for inducing difficult chemical reactions. Nitrogen and oxygen, for instance, could be combined in the heat chamber to form nitrous oxide, a compound widely used in chemical processing. A synthesizer of this type could also find application in processing petroleum products."

Dr. Hutcheson said that the unit's potentialities as a furnace might make a number of refractory metals available in ingot form for the first time. Normally used in powder form, metals such as tungsten are difficult to process because of their high melting points.

In all of these applications, the success of the arc heater "is generally dependent upon a low level of contamination," he said. One of the problems involved in units under development during the past 2 years is that electrodes and walls of the chamber burn and thus contribute impurities amounting to as much as 10% of the mass of the gas flowing through the system, he explained.

"The Westinghouse unit has a guaranteed maximum contamination level of 0.2%," he said. "Still further reductions in this level are contemplated.

"In addition, we believe that the Westinghouse arc heater has a uniform temperature 'profile' within the heat chamber. In other words, the temperature at the entrance to the nozzle is constant."

The basic concept for the new arc heater was proposed by Dr. Werner Emmerich, research physicist at the Westinghouse research laboratories. He conceived a scheme in which an electric arc, dissipating megawatts of electric power, can be maintained for prolonged periods of time to continuously transfer thermal energy to a gas passing through the arc. This is done virtually without erosion of the electrodes, thus all but eliminating this cause of gas contamination.

A key to the performance of the new machine lies in the design of the two electrodes which form the terminals for the arc. Each of these electrodes consists of a hollow donut-shaped ring placed horizontally, one directly above the other. Water is pumped through the hollow rings for cooling.

An electric arc is started by drawing it across the gap between the two rings, and then rotated around the gap at a high rate of speed.

Rotation of the arc is accomplished by a magnetic field from d-c coils arranged around the outside of the heat chamber. This rotation, combined with water-cooling, prevents the electrodes from heating to a point beyond the structural endurance of the material. Repeated tests of the unit have left the electrodes undamaged, indicating a lack of contamination from this source.

The working fluid, such as air or nitrogen, enters the arc chamber and passes into the arc through openings near a water-cooled copper heat shield. The water-cooled heat shield, which can withstand arc temperatures well above 10,000 F without eroding, protects the walls of the arc chamber. After leaving the arc, the fluid passes through a water-cooled nozzle.

The new unit was designed and built by a group of engineers headed by Armin Bruning, who is in charge of advanced development for the marine, transportation, and aviation facility engineering department at the company's East Pittsburgh, Pa., plant.

The prototype arc heater was designed to accommodate a 1.2-pound-per-second flow of either air or nitrogen. The unit should be able to supply gas at 1,500 psi with a constant enthalpy of more than 2,000 Btu per pound for as long as 10 minutes without damage or measurable gas contamination. The efficiency of heat transfer to the gas is in excess of 50%.

More than 50 tests of the prototype arc heater have been successfully completed, and testing will continue until the design limits of the equipment have been verified.

So far, the highest pressure at which tests have been conducted is 730 psi. Other tests with a power input of 549 volts and 5,046 amperes (9,450 kw per pound per second) have raised the enthalpy of air passing through the chamber 4,670 Btu per pound. Equipment of this type can use either direct or alternating current, single or three phase.

The arc heater was developed by Westinghouse specifically for use as a high-temperature air supply for the study of missile re-entry problems. A variation of the prototype model is now available to the aircraft industry for this application.

Advances in arc-heater technology should enable Westinghouse to offer equipment to the metal, chemical, and petroleum industries within 1 or 2 years. It will find applications wherever gasses at extremely high temperature and pressure can be used to advantage. Presently, these industries have no practical means of producing temperatures of 10,000 to 20,000 F in gases at high pressure over a sustained period of time.

The Westinghouse power circuit breaker department has product responsibility for the arc heater. This department has more than 60 years experience in arc control and power-circuit interruption.

Main components of the equipment are an arc chamber and a power supply. The arc chamber consists of a heavy steel envelope in which are housed the electrodes, the magnetic arc-rotator coil, a nozzle, and a variety of auxiliary mechanisms. The power supply for an a-c system includes reactors, transformers, switchgear, and control circuitry. A d-c system which uses a rectifier can also be supplied.

Depending on wind-tunnel-facility power requirements, an arc heater with its power supply may cost from $500,000 to $1,500,000.

EE

Productograph Industrial Control System

The Productograph system, an advanced concept in industrial control which outmodes the paper-and-pencil method of keeping production data, is being introduced to American industry by the Farrington Manufacturing Company, President W. M. Tetrick announced recently.

Productograph, a German system designed to reduce manufacturing equipment down time (idle time) and to record operations automatically, will be made, sold, and serviced in North America by a subsidiary of Farrington, Needham Heights, Mass.

Custom designed to the requirements of each individual industry, the system is a front runner in the move to automate production control in Europe. It is in commercial operation in more than 200 plants and industries there.

There are presently two Productograph installations in this country—at The Holo-Krome Screw Corp. (a subsidiary of Veeder-Root, Inc.), Hartford, Conn., and at the Connecticut Bending and Stamping Works, New Britain, Conn.

The system is keyed to a console receiving unit, located in a production control center, which can supervise up to 200 machines.

GENERAL VIEW of Productograph console units controlling 40 machines at Connecticut Bending and Stamping Works. The production supervisor at the desk also computes incentive pay from the information recorded on the Productograph system.

Impulse transmitters—such as microswitches, voltage relays, flow meters, and photoelectric cells—and a call station, installed next to the production machine, provide instantaneous and continuous communications with the console operator.

Through this telecommunication system, machine operating times, down times, and the causes for down times are automatically recorded audio-visually on a special graph and on a tape recorder.

By using the call station, a simple control panel, and 2-way telecommunication system, the individual machine operator can immediately inform the production control supervisor of the precise cause of the machine stoppage.

In addition, the number of items being manufactured, time units, nominal and actual output are automatically tallied—both on electrical counters and on linear counters. The linear counters provide a visual record of the quantity of items produced and production time elapsed.

The production control supervisor, through the use of Productograph, can plan the manufacturing work schedule more efficiently and anticipate down times arising from machine breakdown, lack of materials, defective materials, or any other causes.

The output of Productograph can be fed directly into accounting equipment and, in the future, may be fed into Farrington Optical Scanners, unique reading machines which bridge the information feeding gap in automatic data processing, Mr. Tetrick said.

Productograph will enable certain installations to compute factory cost work, payrolls, and other accounting functions. Incentive payments for the machine worker can be computed and paid on the information recorded by Productograph console units.

Productograph equipment has been used in Europe in many areas of manufacturing, such as plastics, metalworking, silk weaving, paper, knitwear, glass, automotive, printing, foundries, packaging, chemicals, steel, wire cables, electrical and electronics, shipyards, coal mines, machine tools, household appliances, rubber and paint.

Productograph can also be utilized outside of the manufacturing field. In a large metropolitan German city, for instance, Productograph is being used to control the peak flow of city traffic.

Mr. Tetrick said startling results have been reported by all users of Productograph. For example, the average down time for all reasons at a leading plastics plant in Germany has been reduced by 86% after 3 years of operation under the system.

Here in the United States, the two users report that down time has been reduced by 22% in about a year's operation under the system.

The North American rights to the manufacture and sale of this equipment were recently acquired by Farrington from Joseph Mayr, who invented and developed Productograph in his electrotechnical plant in Erlangen, West Germany. Siemens & Halske, A. G., of Munich, West Germany, has obtained the European rights.

EE

Large Plexiglas Enclosure Increases Relay Station Capacity

A 560-square-foot enclosure, made of transparent Plexiglas, has been installed by the New York Telephone Company at its microwave relay station on the 87th floor of the Empire State Building. This enclosure has enabled the station to increase the number of its transmission antenna discs from 4 to 12 on this side of the building.

The purpose of the station is to relay television pictures from television cameras to broadcasting points. The station's 50-inch microwave disc antennas receive a television picture from the point of origin, e.g., a studio, sporting field, or celebrity's living room, and then transmit the picture to a specific broadcasting point, where the picture is retransmitted to the public, or to a closed-circuit audience.

Because the antennas must be installed on the periphery of the building, it is necessary to protect them against the elements—particularly the high winds (up to 80 mph) frequently encountered from time to time atop the Empire State Building.

Prior to the installation of the large, "full-sweep" enclosure, the antennas were located on an open platform, just above the observation deck. Each individual transmission disc was protected by an igloo-shaped dome, also made of Plexiglas acrylic plastic, and these domes—7 feet in diameter by 9 feet high—occupied so much of the available platform area that there was room for only four antennas in the space. (There are also four dome-protected antennas on the west side of the building which have not yet been replaced.)

In addition to limiting the number of antennas that could be installed, the dome enclosures had other disadvantages. They tended to accumulate material from the air which adversely affected transmission, and they were exposed to possible breakage from falling ice which builds up on, and then drops from the building's high mast during fall and spring months.

The new location on the 87th floor solves these difficulties. Here, there is no hazard from falling ice and there is now space for 12 antennas instead of only 4. The big discs are now mounted within the actual building area, but there are no walls or supporting structural members except behind the antennas. In front there is nothing but the Plexiglas enclosure between the transmission discs and the open space beyond the building.

The plastic, weathertight enclosure extends across the full width of one side of the 87th floor and continues around the portion of the two ends which have been included in the microwave transmission area (perhaps one third of the length of each end).

The sheet Plexiglas used in the enclosure is formed into a special "flat-bottomed Vee" corrugation pattern. This corrugation serves a dual function; it stiffens the panels to enable them to withstand the high winds, and it eliminates objectionable microwave reflections that might occur from an unbroken flat surface. At the same time, the small flat section of the Vee provides a distortion-free, transparent area through which visual sighting is possible as an aid in positioning the antennas. The panels are mounted with the corrugation in a vertical position to help shed moisture and dirt and the entire enclosure is installed with an inward slope from top to bottom to minimize further the problem of moisture and dirt accumulation.

THIS 6-ft high, corrugated Plexiglas enclosure goes fully around the east side of the 87th floor of the Empire State. Building. The enclosure protects 12 microwave disc antennas one of which is shown being installed.

In selecting a material for the enclosure, a basic consideration was low absorption of the television beam's energy. In addition, a transparent material was desired, as previously explained, to facilitate the initial line-of-sight adjustment of the antenna direction. Also required was full weather resistance, superior strength, shatter resistance, and dimensional stability. Plexiglas acrylic plastic proved able to meet all these requirements.

Universal Unlimited, Inc., formed the special corrugations in the sheet Plexiglas in its fabricating shop in Glen Cove, N.Y., and this firm also handled the installation of the panels on the building.

The greatest distance covered from the Empire State Building relay point is to Crow Nest Mountain at West Point, N.Y., over 40 miles away. For short distances, within a few blocks of the relay station, 2-foot diameter discs may be used.

Plexiglas is a product of Rohm & Haas Company, Washington Square, Philadelphia, Pa. **EE**

First State-wide Educational Television System

South Carolina has placed in operation the initial phase of the first educational television system designed to reach schools throughout a state, it was announced jointly by state officials and the Radio Corporation of America (RCA).

Fifteen schools already have been joined by a closed-circuit television cable hookup running 135 miles from Columbia, the state capital, to Charleston. An additional 65 schools are served by television stations WUSN-TV in Charleston and WNOK-TV in Columbia, broadcasting tape-recorded material prepared in the educational television system's Columbia studio.

A second cable will extend 85 miles northeast from the state capital to Florence and a third leg will reach schools as much as 60 miles to the west of Columbia in South Carolina's mountain country.

"This marks the start of a unique program to bring the best possible instruction to classrooms in every corner of the state," said R. L. Kalmbach, general manager, South Carolina Educational Television Center. "Our public school year covers 180 days. We intend to make full use of teaching by television on 160 of those 180 classroom days.

"Through the medium of television, pupils in the smaller rural school and city school alike will receive the benefits of instruction by some of our most talented teachers," Mr. Kalmabach said. "The individual classroom teacher is being given invaluable assistance by specialists on our education team."

Four subjects are included in the initial television curriculum—elementary algebra, advanced algebra, geometery, and South Carolina history.

C. H. Colledge, division vice-president and general manager, RCA Broadcast and Television Equipment Division, said the main studio in Columbia would be "the envy of many commercial broadcasters."

"The South Carolina educational TV system is equipped to produce program material of the highest quality," Mr. Colledge said, "both 'live' over the cable hookup and in the form of tape recordings which may be used time and again."

Two key studio units are a pair of RCA monochrome television tape recorders, either of which can be adapted readily for color. Tapes prepared on these machines can be played back on any recorder.

Mr. Kalmbach said that at the present time recordings are being made on an average of 3 days in advance of their broadcast. Eventually, he said, lecture series will be made a week or more in advance.

"Use of the TV tape recorders will serve the best interests of pupil and teacher alike," Mr. Kalmbach said. "The pupil will be given a polished, well-informed presentation and the television instructor will have his effort recorded for repeated use."

The studio equipment complement also includes three RCA *TK-11* "live" image orthicon cameras and an RCA *TK-21* film chain, along with associated multiplexer, slide projector, and film projector.

"The TV teacher will be able to use a wide variety of visual aid material, as well as the time-proven blackboard," Mr. Colledge said.

The complex job of shifting from one program source to another will be handled by an RCA advanced *TS-40* transistorized switcher. This unit completes a picture-to-picture transfer so swiftly—in the order of 1 microsecond—that there is no visible disturbance from the viewers' standpoint. Coupled with the switcher is a highly flexible RCA special effects system with provision for up to 150 different transition patterns, as well as picture inserts in a variety of shapes. The instructor, for example, can be shown in one corner of the screen superimposed on a closeup of a demonstration subject.

The South Carolina educational television project is the direct outgrowth of work done by a committee formed in 1958 at the request of the state's General Assembly to study television as a means of upgrading the quality of classroom work.

The closed-circuit system also will be made available to the state Department of Education for teacher training programs.

EE

Automatic Electronic Bank Bookkeeping System

A vast, completely new, fully automatic electronic bank bookkeeping system went into operation recently at the nation's oldest and Philadelphia's largest bank, The First Pennsylvania Banking and Trust Company.

Designed, developed, and built by Burroughs Corporation, the system consists of intricate subsystems linked together into a master system that ultimately will perform all of the bank's major accounting functions automatically through electronics.

Check-out of the system is being conducted on the bank's special checking accounts which brings into operation the latest of the subsystems to be installed—the *B 301* Magnetic Document Processing System, an entirely new Burroughs development.

The *B 301* system uses MICR (Magnetic Ink Character Recognition), the common machine language principle as selected by the American Bankers Association for use throughout the United States. Thus, it uses actual MICR encoded media (checks and deposit tickets) as the input "trigger" of the system.

With the addition of a *B 301* to the Burroughs *220* computer, the master system can operate directly from MICR encoded media as well as from punched paper tape, punched cards, or magnetic tape input, it was pointed out, making it the most flexible bank automation system yet devised and placed in operation.

Operating from precoded MICR customer checks, the *B 301* system will electronically read the checks, edit the coded data, sort, accumulate totals, classify, print listings, and convert acceptable information to magnetic tape for subsequent handling by other subsystems, including the *220* computer and an ultra-high-speed printer.

At speeds of 750 lines of 120 characters per minute, (maximum capability of 1,500 numerical lines per minute) statements are prepared by the high-speed printer at 1,400 statements per hour. The check processor-reader used in First Pennsylvania's system reads and sorts items automatically at speeds up to 1,560 items per minute.

These are the subsystems linked together to form the master system: (a) document encoding and proof system, (b) document sorter and processing system, (c) sorter-lister-converter system, (d) data-processing computer with magnetic tape units, and (e) high-speed printer system.

EE

THE Burroughs *B 301* Magnetic Document Processing System is the heart of the automatic electronic bank bookkeeping system installed in the First Pennsylvania Banking and Trust Company. The system reads, sorts, edits information encoded in magnetic ink on checks, etc.; and records the information on magnetic tape for the Burroughs 220 computer. Shown are two Burroughs sorters, a control unit (*background*), magnetic tape transport (*left*), and electrostatic printer (*right*).

AGS Begins Operation at Brookhaven Laboratory

Commissioner J. S. Graham, acting chairman of the Atomic Energy Commission (AEC), announced that the alternating Gradient Synchrotron (AGS) at Brookhaven National Laboratory, one of the world's two largest operating particle accelerators, ran for the first time July 29, 1960, producing at 4:15 p.m. a beam of protons at an energy of more than 30 billion electron volts (bev). This is the highest energy ever attained by a particle accelerator. Before reaching this energy, the AGS had run for about an hour at 24 bev.

"The Commission is gratified that Brookhaven has successfully completed and operated the Alternating Gradient Synchrotron," Commissioner Graham said. "It is appropriate," he noted "that this fine new research tool is located at the Brookhaven National Laboratory, for it was there, in 1952, that the principle of strong focusing of the particle beams was discovered. If this discovery had not been made, the magnet for an accelerator capable of reaching the desired energy would have been prohibitively large and expensive."

The completion of the AGS represents an important step forward in AEC-sponsored studies of nuclear forces and the properties in subnuclear particles. It will enable scientists in the United States to study nuclear interactions at energies about five times greater than ever before possible. Another accelerator, quite similar in design and size to the AGS, has been completed at the European Organizaion for Nuclear Research (CERN) Laboratory, near Geneva, Switzerland. The CERN Proton Synchrotron first produced a proton beam of 24 bev on November 24, 1959, and has since been run at 28 bev.

Since 1954, the most powerful accelerator in this country has been the 6.2-bev Bevatron at the University of California's Lawrence Radiation Laboratory. With a machine in the 30-bev range, physicists at Brookhaven expect to learn more about the many kinds of particles, such as mesons and hyperons, and the various "antiparticles," that are produced in target nuclei by bombarding them with high-energy protons.

Construction of the AGS, which includes 240 magnets placed in a ring-shaped 18-foot-square tunnel ½ mile in circumference, was started in late 1955, following several years of preliminary design work. The total cost of this latest AEC research facility, including a 60,000-square-foot service and laboratory building and an 85,000-square-foot experimental building, is approximately $31 million.

Perhaps the best way to describe the AGS is to follow a beam of protons from its point of origin until it reaches the desired energy of 25 to 30 bev. These protons are accelerated in three stages. The first stage utilizes a Cockcroft-Walton generator, where protons (hydrogen atoms stripped of their electrons) derived from a low-pressure hydrogen gas discharge are accelerated to 750,000 volts. The second stage of acceleration takes place in the linear accelerator, or "linac." In the 110-foot-long vacuum tank of the linac the protons are given an incremental velocity as they pass through each gap between 124 accelerating electrodes activated by a high-frequency electrical source. The proton beam, having now reached an energy of 50 million electron volts, is guided from the linac into the main synchrotron magnet ring through an elaborate injection system of debunching (smoothing out the pulses as they come from the linac), deflecting, focusing, and monitoring equipment. The third stage of acceleration is performed in a ½-mile circular, concrete-lined tunnel buried under 12 feet of earth. This tunnel houses the magnet assembly for the AGS. It is the function of the main magnet, which is divided into 240 units each weighing some 16 tons, to bend the protons into a circular racecourse, and to apply strong focusing forces which always tend to bring the protons back toward their orbit within the vacuum chamber whenever they tend to stray away from it. Thus, the synchrotron's magnetic field must become stronger during the acceleration period. Since the vacuum pipe is only 6 inches wide and 2¾ inches high, a small fraction of the ring's width, the magnet must be set and aligned to the greatest attainable precision.

The magnet itself does not increase the energy of the beam. This is done by 12 radio-frequency accelerating stations around the ring, each one accelerating the beam by 8,000 volts each time it passes. Thus, for each circuit around the ring the protons gain some 100,000 electron volts. Consequently, in order to reach the final energy of 30 bev, approximately 300,000 revolutions must be made in one second, or 160,000 miles. Toward the end of this 1-second acceleration period, the protons are traveling at a velocity within a fraction of one-tenth of one per cent of the speed of light, or approximately 186,000 miles per second. At this velocity, the mass of the protons has been increased more than 30 times, as predicted by Einstein's theory of relativity.

The proton beam is then directed at appropriate target substances, thus producing reactions which can be studied by means of the emitted radiations. It is expected that eventually the primary beam can be made to do double duty by magnetically deflecting it from the vacuum chamber and guiding it into the experimental area, where a number of separate experiments can be installed along the path of the beam and different portions used simultaneously.

Most of the elementary particles produced by the interaction of the high-energy protons with the nuclei of the target atoms exist outside the atom for only a fraction of a millionth of a second before they decay into other particles or change their mass completely into energy. These brief lifetimes, however, are long enough for the particles to be detected by instruments—counters, bubble chambers, or photographic emulsions—and to determine their mass, electrical charge, and other properties, or to observe the results when they impinge on secondary targets.

EE

Heat Lamps Aid Space Program By Simulating Thermal Barrier

The "thermal barrier," a major obstacle to man's successful venture into space, is being overcome with the aid of a modern, sophisticated version of the common light bulb.

The role of the lamp in space research was discussed by W. F. Hodge, engineer for General Electric's large lamp department, who described the device as a tubular, pencil-thin quartz infrared lamp, capable of producing the intense concentrations of energy required to simulate heating conditions which exist when a space vehicle enters the earth's atmosphere.

By pretesting the heat resistance of materials, structural parts, models or whole structures of missiles, space vehicles, and aircraft, the nation is able to facilitate its program in these fields, he said.

Temperatures of more than 3,000 F, about one third the temperature of the surface of the sun, are being created by closely arrayed banks of the tubular lamps in overvoltage operation, according to Mr. Hodge.

He said the fast heating and cooling characteristics and low thermal capacity of quartz infrared lamps make them "by far the most satisfactory device" for thermal barrier simulation.

Temperatures in this work must be varied rapidly and controlled accurately to produce the same temperature conditions actual missiles would develop in passing through various regions of the earth's atmosphere, it was explained.

The maximum wattage a quartz lamp can withstand is determined by the melting point (about 6,100 F) of the tungsten filament. Lamps designed for 200 watts per inch, now being used in thermal barrier simulation, have been operated successfully for a few seconds, at 1,000 watts per inch.

The engineer revealed that a new lamp General Electric now has under development is designed to operate at 360 watts per inch but is capable of operating at as high as 1,500 watts per inch for very short periods.

It was stated that the operating life of quartz infrared lamps of the type used in aircraft and missile structure testing recently had been improved by using platinum lead-in wires. While oxidation causes the standard seal with molybdenum lead-in wires to break down at 650 F, the new seal will last for 100 hours or more at temperatures of around 1,500 degrees. Lamps with the new seal now are available in eight sizes, ranging from 500 to 5,000 watts.

EE

Electronic De-Icers Chosen For Navy's Light Twin Planes

A new electric propeller de-icing system developed by B. F. Goodrich Aviation for twin-engine aircraft has been selected by the U. S. Navy as equipment for 20 Piper Aztec planes recently purchased for personnel transportation.

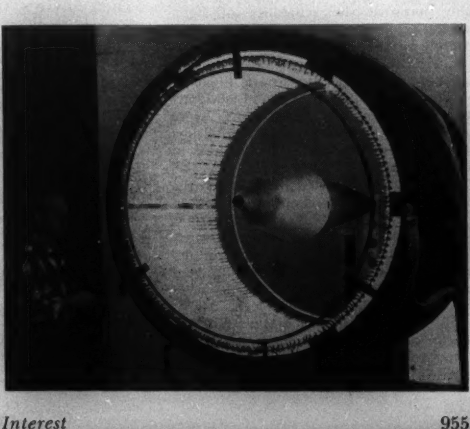
P. W. Perdriau, general manager of the B. F. Goodrich division, said it is the first electric de-icing system for planes of this size. It has been certified by the Federal Aviation Administration as a "non-hazard installation" on the Beech 95 Travel Air, Piper Apache, and Aztec.

It will be supplied in kit form for Aero Commander, Cessna 310, Beechcraft D&E-18, Twin Bonanza, and Model 95.

The new system, used by airlines and the military for much larger planes, is comparable in cost with conventional alcohol de-icers that weigh two to five times as much. It eliminates the weight of alcohol, tanks, pumps, valves, motors, and rheostats required by other systems.

The electric system weighs 8 to 10 pounds complete, depending on the make and model of aircraft. This compares with approximately 35 pounds for a conventional alcohol system for a similar light plane.

The electric de-icer provides consistent protection against ice for unlimited periods while alcohol systems are limited by the amount of alcohol carried to operate



THERMAL BARRIER temperatures are simulated in this nose cone test at the National Aeronautics and Space Administration's Langley Research Center in Virginia. Heat produced by 225 2,500-watt tubular General Electric quartz infrared lamps in the cylindrical radiator reaches 3,100 F, about one third as hot as the surface of the sun. Such tests facilitate the nation's efforts to overcome re-entry problems.

ELECTRIC propeller deicing system developed by B. F. Goodrich for light aircraft is installed on a Piper Aztec at the company's Aviation Products Division, Akron, Ohio. The new system, recently adopted by the U.S. Navy for 20 personnel-carrying Aztecs, is comparable in cost with conventional alcohol systems that weigh two to five times more.

the de-icer. The de-icer requires only 9 to 11 amperes to operate both propeller assemblies.

The only exposed parts are the lightweight, rubber-protected heating elements bonded to the propeller blades. EE

Improved Sight For "Electronic Eyes"

Development of a new photoemissive material that permits "electronic eyes" to operate at high temperatures was announced recently by the Westinghouse Electronic Tube Division.

The search for a more versatile photoemitter, which translates light into electric signals, was conducted by Westinghouse for the U. S. Navy, Bureau of Ships, as part of the long-range supporting research program of the Department of Defense. Photoemission provides the operating principle for a variety of photoelectric tubes, including television camera tubes and light amplifiers.

Dr. W. H. McCurdy, manager of the division's applied research department, said the new photoemitter can considerably improve the reliability of light-sensing devices for space vehicles and other equipment that must operate under high-temperature conditions.

Chief advantage of the new photoemitter is its ability to function efficiently for long periods at temperatures twice the range of present types. In addition, its high sensitivity allows it to operate at low light levels.

Dr. McCurdy reported that tests on the new material show excellent stability when operated as long as 140 hours at 120 C —well above the boiling point of water. "Other photoemissive surfaces begin deteriorating at about 60 C," he said, "and they suffer a large loss in sensitivity after 100 hours at the 120-degree level."

The new photoemitter uses a semitransparent combination of antimony, potassium, and sodium deposited as a thin semitransparent layer on glass. Light striking the layer causes the material coating to release electrons which generate an electric signal. EE

NEW BOOKS

The following new books are among those recently received at the Engineering Societies Library. Unless otherwise specified, books listed have been presented by the publishers. The Institute assumes no responsibility for statements made in the following summaries, information for which is taken from the prefaces of the books in question.

ADVANCES IN COMPUTERS, VOLUME 1. Edited by F. L. Alt. Academic Press, Inc., 111 Fifth Ave., New York 3, N. Y., 1960. 316 pages, 6¼ by 9¼ inches, bound. $10. This volume is the first in a series intended to survey progress in computer programming at frequent intervals and to present the information to others than specialists in the field. The six papers contained here are on methods of programming for business, scientific, and lingual applications. Automatic translation of languages, machine recognition of spoken words, programming for games, numerical weather predictions, general business applications, and binary arithmetic useful in designing computing equipment, are the specific topics covered.

ADVANCES IN ELECTRONICS AND ELECTRON PHYSICS, VOLUME XII: Photo-Electronic Image Devices. Edited by J. S. McGee and W. L. Wilcock. Academic Press, Inc., 111 Fifth Ave., New York 3, N. Y., 1960. 397 pages, 6¼ by 9¼ inches, bound. $12. These 30 papers (2 in French) by authors from England, France, Germany, the Netherlands, and the United States, were presented at a symposium held at London University (1958), devoted to photoelectronic image devices. The editors regret the absence of any papers on solid-state image intensifiers, and of any Russian papers. A large part of the symposium was concerned with the application of photoelectronic image devices to the luminescent particle-track chamber.

ADVANCES IN SPACE SCIENCE, VOLUME II. Edited by F. I. Ordway, III. Academic Press, Inc., 111 Fifth Ave., New York 3, N.Y., 1960. 450 pages, 6¼ by 9¼ inches, bound. $13. In this volume seven American scientists contribute detailed chapters covering six major areas of space science–space physics: "the marriage of geophysics and astrophysics to rocket technology"; the basic scientific and technological purposes and the current methods of tracking of space exploration vehicles; the behavior of materials in the space environment; plasma propulsion devices; electrostatic propulsion devices; and attitude control of space vehicles.

AUTOMATIC LANGUAGE TRANSLATION. By A. G. Oettinger. Harvard University Press, Cambridge, Mass., 1960. 380 pages, 6¼ by 9¼ inches, bound. $8.50. Presenting the results of 10 years of study of the problems of automatic translation, this book emphasizes fundamental lexical and technical aspects, reflecting the author's conviction that an operating automatic dictionary is a basic requirement for the eventual development of an automatic translator. The investigations were confined to translation from Russian to English, and this book describes in detail a proven system of automatic dictionary compilation and operation in that area, as well as one adaptable to other pairs of languages. The final chapter discusses affix interpretation—the extension of an automatic dictionary toward an automatic translator.

AVIONICS RESEARCH: SATELLITES AND PROBLEMS OF LONG RANGE DETECTION AND TRACKING. (AGARDograph No. 40). Edited by E.V.D. Glazier and others. Pergamon Press, 122 E. 55th St., New York 22, N.Y., 1960. 257 pages, 6¼ by 10 inches, bound. 63s. The first six papers of the proceedings of the 1958 AGARD Symposium on the Detection and Tracking of Targets at High Altitudes and Extreme Ranges are theoretical discussions of radar, particularly ionospheric radar and its use in long-range tracking. Other papers record practical experiences with radar, such as echoes received from earth satellites Alpha and Beta, and satellite observations made with the Millstone Hill Radar. Papers dealing with aspects of radio astronomy include those discussing observations of and propagation from the Russian earth satellites, radio-signal-strength records from the Explorer satellites, tracking from the California co-ordinated doppler receiving stations, and the 40-mc "Image" signals from the Alpha satellite.

CRYSTAL-STRUCTURE ANALYSIS. By M. J. Buerger. John Wiley & Sons, Inc., 440 Fourth Ave., New York 16, N.Y., 1960. 668 pages, 6 by 9¼ inches, bound. $18.50. This introduction to the subject describes the methods of finding the locations of the atoms in the unit cell and the theories on which they are based. Opening with consideration of fundamental diffraction relations and the diffraction of X rays by crystals, the author next discusses selection of material suitable for crystal-structure analysis, and the measurement of, and geometrical and physical factors affecting, intensities. He then covers the number and distribution of atoms in the unit cell, the structure-factor and structure-factor calculations, and examples of the determination of some simple crystal structures. The use of Fourier syntheses in analysis is dealt with at length, including discussion of reciprocal space and symmetry and their application in Fourier summations. The final chapters deal with phase and direct determinations, refinement, and the calculation of interatomic distances and angles. This is a companion volume to the author's "Vector Space and Its Application in Crystal-Structure Investigation" (Wiley, 1959), which deals with advanced topics not covered here.

DIGITAL COMPUTER AND CONTROL ENGINEERING. By R. S. Ledley. McGraw-Hill Book Company, Inc., 330 W. 42nd St., New York 36, N.Y., 1960. 835 pages, 6¼ by 9¼ inches, bound. $14.50. This comprehensive elementary engineering textbook presents the major aspects of digital computers and controls for the student engineer. The first part covers general concepts of programming applicable to any computer, and concludes with an exposition of the International Algebraic Language ALGOL. Digital systems design based on numerical analysis and data processing, and logical design of digital circuits utilizing "designation numbers" and applied to all types of arithmetic compounds, are developed and explained. The final part deals with the electronic design of digital circuits, utilizing solid-state and magnetic core components.

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ENGINEERING Societies Library books, except bibliographies, handbooks, and other reference publications, may be borrowed by mail by AIEE members for a small handling charge. The Library also prepares bibliographies, maintains search and translation services, and can supply a photoprint or a microfilm copy of any item in its collection. Address inquiries to R. H. Phelps, Director, Engineering Societies Library, 29 W. 39 St., New York 18, N. Y.

ELECTROMAGNETIC WAVE PROPAGATION. Edited by M. Desirant and J. L. Michiels. Academic Press, Inc., 111 Fifth Ave., New York 3, N.Y., 1960. 730 pages, 6 by 9¼ inches, bound. $22. The papers presented at one of the International Scientific Conferences sponsored by the Postal and Telecommunications Group of the 1958 Brussels International Exhibition form the contents of this book. There are 54 papers (4 in French, 4 in German), discussing various aspects of recent developments and scientific progress in the study and use of electromagnetic wave propagation.

ELECTRONIC PROCESSES IN SOLIDS. Based on lectures given by P. R. Aigrain. Edited by R. J. Coelho and Gianni Ascarelli. John Wiley & Sons, Inc., 440 Fourth Ave., New York 16, N.Y., 1960. 67 pages, 6 by 9¼ inches, bound. $4. This monograph is an extension and modification of 8 lectures presenting the physical background of electric conduction phenomena in crystals, originally given in 1957 at Massachusetts Institute of Technology by visiting Webster Professor (E.E.) P. R. Aigrain. A fair background in calculus and elementary wave mechanics is needed. The 15 short sections study the motion of electrons without and with an applied field, formulation and solution of the electronic wave equation, conduction theory and phenomena, transport theory, statistical mechanics of electrons in solids, and phonon and nonintrinsic scattering of electrons.

ELECTRONICS FOR SPECTROSCOPISTS. (Schwartz Memorial Volume). Edited by C. G. Cannon. Interscience Publishers, Inc., 250 Fifth Ave., New York 1, N.Y., 1960. 333 pages, 5¾ by 8¾ inches, bound. $9.50. This volume contains lectures of a special course given at Southampton University (England), 1949-50, to meet the need for knowledge of the electronic techniques used in spectroscopy by those engaged in the field. The 14 papers discuss a-c theory, types and design of amplifiers, feedback, power supplies, noise, semiconductors in radiation detection, photoelectric devices and their applications in the visible and ultra-violet regions, various aspects of infrared spectrometry, and special optical problems.

FUEL CELLS. Edited by G. J. Young. Reinhold Publishing Corporation, 430 Park Ave., New York 22, N.Y., 154 pages, 6¼ by 9¼ inches, bound. $5.75. This volume contains the papers and subsequent panel discussion heard at a 1959 Symposium sponsored by the American Chemical Society. The nine papers include a general introduction to fuel cells, and discussion of high- and low-temperature hydrogen-oxygen fuel cells, carbonaceous fuel cells, the electrode processes in fuel gas cells, molten alkali carbonate cells, catalysis of fuel-cell electrode reactions, and electrode kinetics of low-temperature hydrogen-oxygen fuel cells.

INFRARED RADIATION. By H. L. Hackforth. McGraw-Hill Book Company, Inc., 330 W. 42nd St., New York 36, N.Y., 1960. 303 pages, 6¼ by 9¼ inches, bound. $10. This book presents information on the components of infrared radiation units and the laws of physics by which they operate. It then outlines the applications and potentialities of infrared in science, medicine, technology, and industry. A generalized infrared system is developed step by step from the source of the signal through the methods of transmission to the final display. The latest material on infrared artificial sources, research in wavelength transmission, infrared instruments, detectors, and spectroscopy is given.

AN INTRODUCTION TO LINEAR PROGRAMMING AND THE THEORY OF GAMES. By S. Vajda. John Wiley & Sons, Inc., 440 Fourth Ave., New York 16, N.Y., 1960. 76 pages, 5½ by 8¾ inches, bound. $2.25. This is an elementary British treatment of two mathematical techniques fundamental to Operational (Operations) Research. Linear programming is dealt with mainly as a simple numerical method, examining the transportation problem, graphical representation, the Simplex Method, complications and their resolution, and duality. The theory of games is evolved from the basis of linear programming and includes discussion of normalization, graphical representation, nonzero-sum games, more-person-games, and infinite games.

KRANKHEITEN ELEKTRISCHER MASCHINEN, TRANSFORMATOREN UND APPARATE. By Robert Spieser. Second edition. Springer-Verlag, Berlin, West Germany, 1960. 376 pages, 6½ by 9½ inches, bound. DM 48. The need for collected information on electrical plant troubles has inspired this German treatise on causes, results, cure, and prevention of faults and failures in heavy current machines, apparatus, and plant. The book covers installation and operational faults of electrical machines, transformers and auxiliary apparatus, with particular reference to the materials employed and the troubles directly resulting from them.

PHYSICS OF THE UPPER ATMOSPHERE. Edited by J. A. Ratcliffe. Academic Press, Inc., 111 Fifth Ave., New York 3, N.Y., 1960. 586 pages, 6¼ by 9¼ inches, bound. $14.50. Eleven chapters of this book are detailed monographs on particular topics by specialists, all concerned with that part of the atmosphere above the height of 60 km. These deal with the thermosphere, the ionosphere, the properties and constitution of the upper atmosphere and its study by rockets and satellites, the airglow, general characteristics of auroras and their study by means of radar, interpretation of the auroral spectrum, and consideration of geomagnetism and meteors in the upper atmosphere. The final chapter contains brief comment on advances during the IGY 1957/58 in each field, written by the author of the relevant chapter of this book.

PROGRESS IN CRYOGENICS, Volume 2. Edited by K. Mendelssohn. Academic Press, Inc., 111 Fifth Ave., New York 3, N.Y., 1960. 280 pages, 6¼ by 10 inches, bound. $11.50. Volume 2 of the series summarizing articles on the whole field of low-temperature methods and techniques, as distinguished from low-temperature physics or chemistry presents papers on the storage and handling of cryogenic liquids; the gas refrigerating machine; bubble chambers; resistance thermometers; the 3-level solid-state maser; methods of nuclear orientation; the 1958 scale of temperatures for the liquid helium-4 region; and industrial low-temperature distillation for deuterium.

PROPERTIES OF ELEMENTAL AND COMPOUND SEMICONDUCTORS. Edited by H. C. Gatos. Interscience Publishers, Inc., 250 Fifth Ave., New York 1, N.Y., 1960. 340 pages, 6¼ by 9¼ inches, bound. $8.50. This volume contains the papers and discussions of a Technical Conference (September 1959) sponsored by the Semiconductors Committee of the Metallurgical Society and the Boston Section of the American Institute of Mining, Metallurgical and Petroleum Engineers. The first four sections of the book deal with metallurgical and chemical aspects, solid-state and surface reactions, chemical and lattice defects, and physical properties and device applications. The final section of the book is a record of a panel discussion on the role of dislocations in device properties.

THE RADIO NOISE SPECTRUM. Edited by D. H. Menzel. Harvard University Press, Cambridge, Mass., 1960. 183 pages, 6½ by 9½ inches, bound. $7.50. This book deals with the problem of radio noise and its sources, whether man-made or natural, over the known range of frequencies. The information presented will aid the communicator in estimating potential interference from various types of sources and will stimulate scientific thought on the origins and significance of characteristic noise radiations. Some of the topics included are meteor scatter, whistler-mode propagation, noise of planetary origin, noise maps, cosmic radio noise, electromagnetic emission from meteors, and interstellar hydrogen.

TECHNIK DER MAGNETSPEICHER. Edited by Fritz Winckel. Springer-Verlag, Berlin, West Germany, 1960. 614 pages, 6½ by 9½ inches, bound. DM 72. In this treatise on the varied and expanding field of magnetic recording, the uniform physical aspects are developed in order to assist the practical engineer in this fairly new technique. Also discussed are the practical applications of the tape: in computers; in sound technique for radio and film; in magnetic television records; and, finally, in the many branches of industry for measuring, supervising, control, automation, etc. The appendix includes conversion tables and a subject index.

WELDING HANDBOOK, SECTION THREE: MISCELLANEOUS METAL JOINING AND CUTTING PROCESSES. Edited by A. L. Phillips. Fourth edition. American Welding Society, 33 W. 39th St., New York 18, N.Y., 1959. Various pagings, 6 by 9¼ inches, bound. $9. Inclusion of chapters on the adhesive bonding of metals and the welding of plastics in this handbook marks the recognition by the AWS of adhesives as structural materials and of plastics as weldable materials. Other topics covered include forge, thermit, induction, ultrasonic, and stud welding, welding by cold working, surfacing, brazing, soldering, arc and oxygen cutting, and metal and ceramic spraying. Section 1 of the Handbook—General; Section 2—Gas, Arc, and Resistance Welding Processes; Sections 4 and 5 to follow.

PROGRESS IN NON-DESTRUCTIVE TESTING, Volume 2. Edited by E. G. Stanford and J. H. Fearon. The Macmillan Company, 60 Fifth Ave., New York 11, N.Y., 1960. 250 pages, 6¼ by 10 inches, bound. $12. This is the second volume in a series of annual critical reviews on international progress in non-destructive testing. Papers included cover the uses of radiology with high-energy X rays, electrical methods, radioisotopes, ultrasonic waves, and paramagnetic resonance in this type of testing. The theory and practical application of these methods of studying and detecting flaws in metal structure are presented, as well as studies of aging and precipitation in metals using anelastic damping measurements. The mechanical testing of high polymers is also dealt with.

REACTOR HANDBOOK, Volume I: Materials. Edited by C. R. Tipton, Jr. Second edition. Interscience Publishers, Inc., 250 Fifth Ave., New York 1, N.Y., 1960. 1207 pages, 7½ by 10 inches, bound. $36.50. This revised compilation of data on reactor materials is organized along the lines of the functional utilization of the materials within a reactor, thus extending the coverage to include liquids and gases as well as solids. Other additions include information from the results of research published since 1955, including that on irradiation behavior. The contributors are American, but international research and literature has been used as source material. A general section contains papers on health, safety, and radiation damage. The other sections cover fuel materials, cladding and structural materials, control materials, moderator materials, coolant materials, shielding materials. The 32-page appendix is a selected list of literature references on binary constitutional diagrams.

THE RELAY PROTECTION OF HIGH VOLTAGE NETWORKS. By G. I. Atabekov. Pergamon Press, 122 E. 55th St., New York 22, N.Y., 1960. 564 pages, 6¾ by 10 inches, bound. $14. This English edition of a Russian work deals with the theoretical aspects of the subject for specialists in the field. Relevant aspects of sequence networks, the vector locus method, symmetrical component filters, power directional devices, and the principles of construction and methods of theoretical analysis of systems of transmission line and bus-bar protection are discussed. Also included is consideration of the principles of auxiliary devices which serve for the selection of the faulty phase and for preventing the incorrect operation of protective gear during swings and for faulty conditions in the secondary windings of voltage transformers.

SELF-SATURATING MAGNETIC AMPLIFIERS. By G. E. Lynn and others. McGraw-Hill Book Company, Inc., 330 W. 42nd St., New York 36, N.Y., 1960. 217 pages, 6¼ by 9¼ inches, bound. $8. This is a thorough treatment of the subject which should interest both the practicing engineer and the student. Introductory chapters cover basic fundamentals and material properties, and include reviews of transformer theory and magnetic theory. A later chapter is a refresher on feedback theory. The remaining chapters discuss in detail the mechanics of operation, design methods for typical circuits, special design problems, and applications of self-saturating magnetic amplifiers.

STATISTICAL PROCESSES AND RELIABILITY ENGINEERING. By D. N. Chorafas. D. Van Nostrand Co., Inc., 120 Alexander St., Princeton, N.J., 1960. 438 pages, 6¼ by 9¼ inches, bound. $12.75. This book treats statistics as a fundamental tool of scientific investigation, presenting and explaining its laws, and its relationships with engineering disciplines and practices. A systematic and mathematically complete presentation of statistical techniques is followed by discussion of statistical methods in the testing of hypotheses. The next three sections of the book describe in detail stochastic processes, information processes, and quality control. The final section, the climax of the whole discussion, considers the use of probability theory in designing for reliability and in reliability tests of products—that is, "reliability engineering."

TECHNICAL COMMUNICATION. By G. C. Harwell. The Macmillan Company, 60 Fifth Ave., New York 11, N. Y., 1960. 332 pages, 6 by 8½ inches, bound. $5. Written with the engineering student in mind, this book will also be useful to the practicing engineer and those in some other professions. The first three chapters discuss the qualities of good writing, the organization of material, and the use of exposition. The business letter is covered in detail. There is an extended treatment of reports and information on technical articles, magazine writing, oral communication, and the use and preparation of tables and figures. The final section of the book is a manual of general composition, containing a review of the general principles of composition and a glossary of usage.

TECHNICAL LITERATURE

The following recently issued technical literature may be of interest to readers of *Electrical Engineering*. All inquiries should be addressed to the issuers.

POWER TRANSISTOR HANDBOOK. Devoted entirely to power transistor theory, design, and applications, this 200-page handbook serves as a reference as well as an introduction to power transistor applications. Mechanical, electrical, and thermal characteristics, plus maximum ratings and characteristics are comprehensively covered. Important factors such as voltage and current ratings, bias considerations, thermal stability, efficiency, and distortion are discussed fully. Circuit designs include high-fidelity amplifiers, converters and inverters, oscillators, time base generators, and television horizontal deflection systems, among others. Selection charts that provide the designer with valuable help, as well as representative specifications, power transistor outline drawings, and derating curves are included, both for industrial and military types. A comprehensive list of symbols and abbreviations in general use are also included. Copies of the handbook are available for $2 each from the Technical Information Center, Motorola Semiconductor Products, Inc. 5005 E. McDowell Rd., Phoenix, Ariz.

SYMPOSIUM ON SPECTROSCOPY. The use of various sections of the electromagnetic spectrum for analytical and research purposes has expanded in recent years at a tremendous rate. This symposium concerned with "unsolved problems" includes representative papers in six distinct fields of spectroscopy. The reader will find advanced thinking in emission, X ray, flame photometry, ultraviolet absorption, magnetic resonance, and infrared spectroscopy. In addition to treatment of many sophisticated approaches to analytical problems, the book contains a report on Soviet progress in the field of molecular spectroscopy. Copies may be obtained from American Society for Testing Materials, 1916 Race St., Philadelphia 3, Pa., at $7 each.

MAGNETIC AMPLIFIERS—PRINCIPLES AND APPLICATIONS. Starting with a review in the field of magnetism, this book proceeds to the saturable reactor, discussing selfstarting and 3-legged core magnetic amplifiers, compensating magnetic amplifiers, polarized magnetic amplifiers, and variations of these. Having established the theory of the magnetic amplifier, the text then deals with amplifier gain, feedback, and general uses and construction. The very important topic of maintenance and troubleshooting is covered from a practical viewpoint. A final section on system applications shows diagrammatically a vast number of practical applications of magnetic amplifier circuitry, together with a thorough discussion of each application. The book may be ordered from John F. Rider Publisher, Inc., 116 W. 14th St., New York, N.Y. The price is $2.45 per copy.

THERMOELECTRIC MATERIALS AND DEVICES. Based on a special series of lectures delivered by 20 experts at New York University (NYU), edited by I. B. Cadoff and E. Miller of NYU's College of Engineering, this volume provides further understanding of heat transfer, electrical conductivity, and related characteristics of semiconductors and other solid-state materials that are connected with these unconventional devices. It will be of special value to metallurgists, electrical and electronics engineers, and physicists about to enter, or already in the thermoelectric field. Copies priced $9.75 each are available from the Reinhold Publishing Corporation, 430 Park Ave., New York 22, N.Y.

IEC PUBLICATIONS. The following International Electrotechnical Commission (IEC) publications have been made available through the American Standards Association (ASA): *Recommendation of Efficiency of Rotating Electrical Machinery* (IEC Publication 34-2) sets forth the losses to be included for the different types of electrical machines when the efficiency is determined by the method of summation of losses, price $3.20; *Particular Specifications for Electric Mains-Operated Television Receiving Apparatus* (IEC Publication 65, Appendix III), details the safety requirements which should be incorporated in the apparatus, price $1.60; *Recommendations for Voltage Measurement by Means of Sphere-Caps* (IEC Publication 52 applies to the measurement of the peak value of alternating voltages, full standard or longer-tailed impulse voltages. Price $3.20; *Recommendation for Commercial Annealed Aluminum Electrical Conductor Wire* describes the physical and mechanical property values of commercial annealed aluminum electrical conductor wire having a diameter greater than 1 mm. Price 80¢. All of these publications may be obtained from ASA, Dept. PR180, 10 E. 40th St., New York 16, N.Y.

ULTRASONIC WELDING. Prepared by a committee of experts in the ultrasonic welding, metallurgical, manufacturing, and research fields, this booklet discusses concisely a welding process which has great potential for future development. Many similar and dissimilar metals which were previously considered unweldable can be welded by this process. By introducing a high-frequency vibratory energy into the metals, ultrasonic welding produces a sound metallurgical bond without arc or spark, melting of the base metals, or deformation of the materials being welded. This 38-page booklet with 29 illustrations contains sections discussing fundamentals of the process, the metals which can be welded, welding techniques, weld characteristics, quality control, equipment, and applications. Copies, at $1.50 each, are available from the American Welding Society, 33 W. 39th St., New York 18, N.Y.

RESISTANCE WELDING CONTROL (NEMA standard IC-2-1960) includes definitions and cycle diagrams for all generally used resistance welding processes. Definitions and diagrams are cross-referenced with a master table listing National Electrical Manufacturers Association (NEMA) identification numbers for the control equipment required to perform each of the described functions. All major control manufacturers list this equipment by NEMA number, as well as their own model or type numbers. Also listed are minimum standards for such factors as accuracy, time range, size, and capacity. Separate sections are included for frequency converter controls, gun welder controls, and multifunction process timers. Copies may be obtained from NEMA, 155 E. 44th St., New York 17, N.Y., at $1 per copy.

NUCLEAR POWER "PROGRESS CHART." A new "progress chart" showing the major industrial participants involved in 39 nuclear power projects in the United States and five other countries is printed on 22- by 29-inch sheet. It contains data on owner/operator, location, type, fuel, power level (thermal and electrical), completion date, architect-engineer of reactor system, reactor system builder, constructor, core/fuel element supplier, and manufacturers of reactor vessel, steam generator, and turbine generator. Copies of the chart are available from the Atomic Industrial Forum, 3 E. 54th St., New York 22, N.Y., for $1 each.

VOLTAGE DROP MONOGRAPHS. Charts measuring 11 by 13½ inches, one each for copper conductors in magnetic conduit, copper conductors in nonmagnetic conduit, aluminum conductors in magnetic conduit, and aluminum conductors in nonmagnetic conduit, determine voltage drop for single-phase circuits 208 and 240 volts and 3-phase circuits 208, 240, 460, 480, and 550 volts, for line currents up to 1,000 amperes and circuit runs up to 1,000 feet, at power factors from 70 to 100%, and for wires from No. 8 to 800,000 cm. A right-angle triangle is all that is necessary to solve the problems. The four charts at $2 per set or 3 sets for $5 can be obtained from H. A. Dodge, P. E., 250 E. 43rd St., New York 17, N.Y.

LIGHTING HANDBOOK. This revised, 250-page pocket-size manual contains comprehensive coverage of the general field of modern lighting practices. Included is a fold-out page in full color of the electromagnetic spectrum, information on distribution and light measurements, a section on the newest light sources, information on coefficients of utilization and maintenance factors, together with footcandle tables. The manual also contains chapters on interior wiring, school and office lighting, industrial and architectural lighting, germicidal and sun lamps, and the cost of lighting. It may be purchased from Westinghouse Lamp Division Headquarters, Bloomfield, N.J., for $3 per copy.

RUSSIAN TECHNICAL JOURNALS. Publication of the "Soviet Instrumentation and Control Translation Series" by the Instrument Society of America (ISA) under a grant from the National Science Foundation will be continued with the 1960 issues during the coming year. The four journals translated into English are: *Automation and Remote Control, Measurement Techniques, Instruments and Experimental Techniques, and Industrial Laboratory.* These monthly publications are available at subscription rates ranging from $20 to $35 per annual subscription. On a combined order for all four journals special rates apply. Libraries and nonprofit academic institutions are offered subscriptions at special rates. For information write to Foreign Translations Department, ISA, 313 Sixth Ave., Pittsburgh 22, Pa.

Every time another American missile is fired, special new cables are put to the toughest test of all.

These cables *must* perform. If they failed there'd be no telemetering, data recording, circuit checks, electronic computing, etc.

To create such cables, you need special research and engineering skills, special experience, *and a hard-headed stubbornness about quality*.

That's why you find so many millions of feet of these specially designed instrumentation cables bear the label, "Rome Cable division of Alcoa."

Two places to look next time you need a cable that never existed before

Look down.

Learn the capabilities of your cable maker, the types of insulations available, the standards to which his cables are built. Look over some typical cables—from 2 to 193 conductors in each—to get an idea of what he can do for you.

Arm yourself with a copy of our Bulletin RCD-400, "Instrumentation Cables". It even contains a "Cable Procurement Information Form," on which you can outline your needs.

No obligation, of course. Just write for a copy. Department 3-100, Rome, New York.

ROME CABLE
DIVISION OF **ALCOA**

2 Look down
Instrumentation Cables
ROME CABLE

HOW MUCH DOES
UNPLANNED DOWNTIME COST IN YOUR PLANT? $1000 . . . $5000 . . . $10,000 an hour?

In many cases the costs in spoiled processes and lost production amount to several times those figures.

You Can't Bargain With Trouble!

Only preventive measures will reduce it. Periodic inspection of important electrical equipment with a Megger® Insulation Tester, and the records of these tests, will provide the data you need to anticipate trouble—to prevent production line interruptions.

Buy Prevention—Improve Profits

Megger "instruments for prevention" cost only a small fraction of the price of equipment failure, work spoilage and the many other wastes that help to destroy the profits picture.

An investment in a Megger Insulation Tester is like the premium on an accident policy except that the Megger Tester can be the means of preventing the accident.

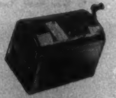
Preventive Maintenance Is Productive

Any production department will thank and even praise a *preventive* maintenance department for its ability to spot trouble before it happens.

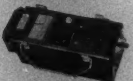
We have the answers—want them?

Write for Electrical Preventive Maintenance material—File 21-EE

MEG® TYPE OF MEGGER INSULATION RESISTANCE TESTER—Available hand-operated, rectifier operated, or with a separate rectifier. Ranges up to 2000 megohms and 1000 volts d-c in all three models. BULLETIN 21-45-EE



MEGGER GROUND TESTER measures the resistance of earth to ground connections simply, easily and accurately, and thereby helps to determine whether such connections will perform the services for which they were designed and installed. BULLETIN 25-EE



MEGGER LOW RESISTANCE OHMMETER—Battery or rectifier operated. Four ranges 0-1000 microhms to 0 to 1 ohm. New clamp type test leads 18 ft. long enable one man to make tests. BULLETIN 24-46-EE.

81014

BIDDLE INSTRUMENTS

JAMES G. BIDDLE CO.
Electrical & Speed Measuring Instruments
1316 ARCH STREET • PHILADELPHIA 7, PA.

New & Improved Products

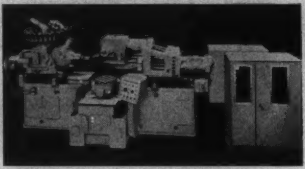
(Continued from page 8A)

Lightweight Capacitors . . .

Two newly designed lightweight power capacitors in the 50- and 100-kvar range make use of an improved kraft paper dielectric to bring about substantial size and weight reductions. The 100-kvar capacitor is said to be from 14 to 19% lighter and 21 to 24% smaller than those presently available. The 50-kvar unit is 18 to 25% lighter and commensurately smaller. In addition, the apparatus is said to have 15% lower watt losses over an extended temperature range. *Sangamo Electric Company, Springfield, Ill.*

Tape-Controlled Machine . . .

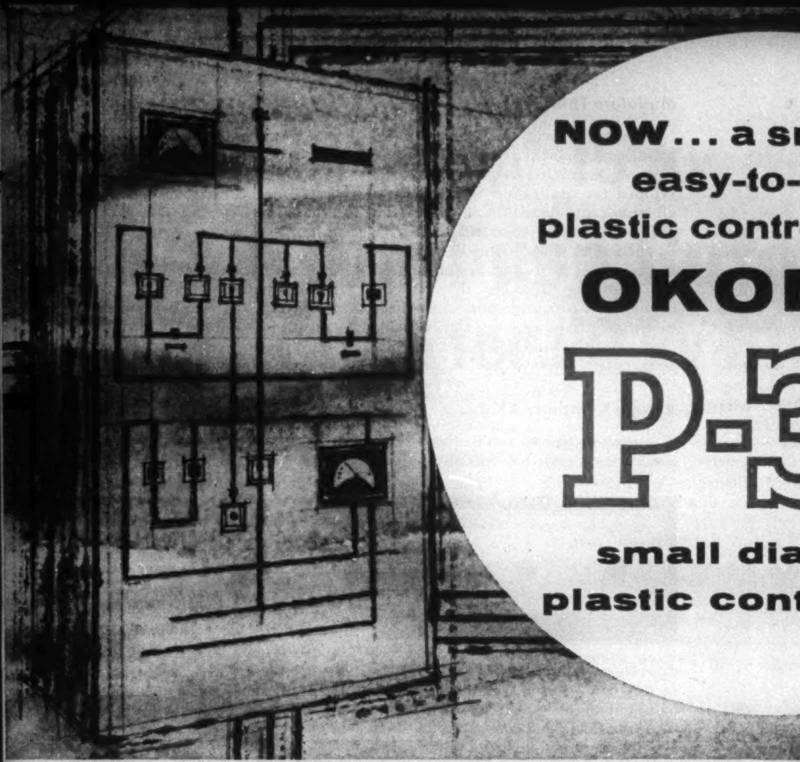
This newly developed tape-controlled machine tool will bring production line efficiency to batch lot production on machined parts aggregating 1 cubic foot in dimension. Designated *MT-3,* the fully automated system features a universal drilling, tapping, and boring head with a storage capacity for 30 tools chargeable in less than 3 seconds. Others include a face milling head and an optional multiple spindle drill head or precision boring head with a 14-tool capacity changer. *Hughes Aircraft Co., P. O. Box 90904, Airport Sta., Los Angeles 45, Calif.*



Machine Control . . .

Automatic numerical control for machine tools may soon be within the budget range of small manufacturers and job shops due to the development of a system that employs no costly electronic gear. Actuated by means of a punched tape input or, if desired, manually or by dial console, the system converts pneumatic pressures into oil power which operates pistons for precision table positioning. Applicable to most types of point-to-point machine tools, the system has a guaranteed repeatability of ±0.0003 inch and table positioning tolerance of ±0.0005 inch. *Moog Servocontrols, Inc., Proner Airport, E. Aurora, N. Y.*

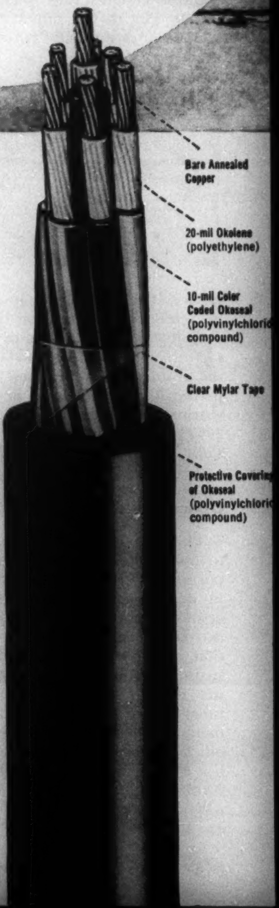
(Continued on page 28A)



NOW... a small, light, easy-to-install plastic control cable...

OKONITE P-30

small diameter plastic control cable


Bare Annealed Copper
20-mil Okolene (polyethylene)
10-mil Color Coded Okoseal (polyvinylchlorid compound)
Clear Mylar Tape
Protective Coverin of Okoseal (polyvinylchlorid compound)

SMALL-CABLE SIZE, BIG-CABLE PERFORMANCE. That's the story on Okonite's new P-30—the multiple conductor cable designed especially for modern control systems where space is limited. Suitable for either a-c or d-c circuits, 600-volt rating, it's recommended for d-c circuits in wet locations and for temperature ranges to 75C. Rugged Okoseal jacket is moisture and flame resistant, provides a smooth surface for easy pulling.

To meet the trend toward lighter, more compact control systems in industry and utilities, Okonite now introduces P-30, a superior quality, small diameter, all-thermoplastic control cable. It's an ideal lightweight, general purpose cable for all types of installations—conduit, aerial, duct, tray, direct burial . . . in wet or dry locations.

Over 30% smaller and lighter than conventional-size rubber cables, Okonite P-30 nevertheless provides the kind of performance normally associated with many larger diameter cables. The multi-wall construction of P-30 offers three-fold electrical protection, since both the two protective coverings and the basic insulation are high quality dielectrics.

P-30 is especially suited for use under rigorous conditions. Double-wall construction provides excellent resistance to the chemical attacks of oils, acids, alkalies and other materials. The protective jacket of Okoseal—extruded over the cable assembly—assures a moisture- and flame-resistant covering.

Another example of Okonite *Cable'bility** in action . . . P-30 is designed to give years of trouble-free service on vital installations. For complete details, write for Bulletin 1140, The Okonite Company, Subsidiary of Kennecott Copper Corporation, Dept. EG, Passaic, New Jersey. 7983

*Okonite Cable'bility... Cable Craftsmanship since 1878.

where there's electrical power . . . there's

OKONITE CABLE

New & Improved Products

(Continued from page 26A)

Self-Balancing Metal Detector . . .

Processors of food, plastic sheet, film, wood products, and similar goods will find use for this stable metal detector that eliminates the need for frequent balancing. Model 200A will locate small ferrous or nonferrous tramp-metal particles as small as 0.063 and 0.085, respectively, at conveyor belt speeds of 1 to 100 feet per minute. The detector permits unattended operation regardless of changes in temperature, humidity, and barometric pressure. *Electro-Mechanical Research, Inc., Sarasota, Fla.*

Teflon Marker . . .

A method has been developed to mark part numbers and other information on Teflon. Key to the process is a compound called *PA-746* that reacts with the Teflon surface to create a dark carbon film that is impervious to the temperatures normally encountered in service. The treating agent is supplied in a polyethelene squeeze bottle with a long, tapered nozzle. Viscosity is such that the fluid will not leak out of the nozzle unless pressure is applied permitting the bottle to be used as a writing instrument. *Plastic Associates, 2900 S. Coast Blvd., Laguna Beach, Calif.*

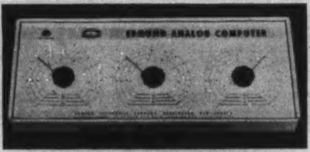
Optical Transducer . . .

The purpose of these transducers is to obtain stable electrical pulses proportional to rotational velocity for use in decade counters and other pulse-operated tachometers. Advantages are extreme sensitivity without amplification, a nearly flat response over a wide frequency range, and a rugged, long life due to the absence of vacuum tubes. Speed range is 180 rpm minimum to 300,000 rpm maximum, without amplification. Amplitude is not less than 3 volts rms at 180 rpm and 2 volts rms at 200,000 rpm. *John Chatillion & Sons, 85 Cliff St., New York 38, N.Y.*

Miniature Thin Resistors . . .

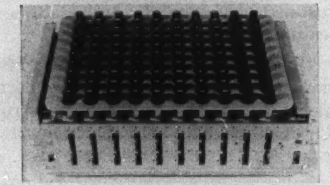
Unusually small for their power-handling capability, these wirewound, vitreous enameled resistors were developed for application where space is all-important. Available in three sizes of 10, 15, and 20 watts, the cores are 1/8 inch thick and in the 10-watt unit 3/4 inch long. Hot spots are minimized by mounting brackets that extend through the core and conduct the heat directly to the chassis or mounting surface. *Ohmite Manufacturing Co., 3609 Howard St., Skokie, Ill.*

Analog Computer Kit . . .



A new, easy-to-assemble analog computer kit is available for training industrial personnel, students, and others in this new science. Operating on two flashlight batteries, the device demonstrates basic analog computations such as multiplication, division, powers and roots, log operations, trigonometry, physics formula solutions of conversions, magnetism, electricity, and geometry. *Edmund Scientific Co., Barrington, N. J.*

Pushbutton Crossbar Switch . . .



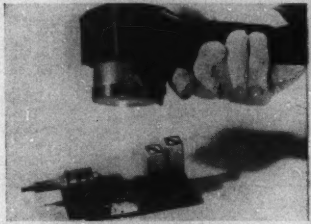
Designed to eliminate the expense of wiring a large matrix of individual switches, this patchcord switching device can handle anything from the microvolt d-c signal of a thermo-couple to the megacycle signals of radar. A constant characteristic impedance throughout the switch of 75 ohms and the ability to handle high-frequency signals makes it useful in radar and color television applications. Because noise induced in the contacts from the actuators is less than five microvolts, and thermoelectric noise less than 0.01 microvolt per degree C, the switch can be used with very low level thermocouple and strain signals. Each button has a vertical marking which indicates immediately whether its contacts are closed or open. *James Cunningham, Son & Co., Inc., P.O. Box 516 Zone 2, Rochester 8, N.Y.*

Substation Planning Aid . . .

A new, economical approach to substation planning can be made with this compact, Regu-Tran assembly, consisting of three single-phase regulators directly mounted on a 3-phase power transformer with a by-pass switch located above each regulator. This simplified arrangement gives single-phase regulation with three-phase unit assembly. As a result, the unit conserves valuable substation space by requiring only one low-cost concrete pad for mounting the entire assembly. *Allis-Chalmers Manufacturing Co., Milwaukee 1, Wis.*

Epoxy Spray Gun . . .

Virtually any thickness of epoxy resins can be spray-deposited with this new type of jet gun. In addition to exceptional bonding, this surface coating method offers deep penetration of the resins, an important factor in coating complex devices such as electric motor stators and rotors. *Plasmadyne Corp., 3839 S. Main St., Santa Ana, Calif.*



Electric Car . . .

A 1-battery electric car for in-plant transportation seats one man and his equipment, yet weighs only 181 pounds. Other features include a low center of gravity, and a safe speed limit of 4½ miles per hour. Designed for plant executives, supervisors, maintainance men, spot checkers, and other personnel, the car is narrow enough to get through the tightest aisles. Each car contains its own charger which will drive it 10 miles at full charge. *The Birdie Co., Inc., 393 Springfield Ave., Summit, N.J.*

(Continued on page 30A)

New 15 kv
G&W Oil-Fuse Cutouts
are full-rated for 110 kv BIL duty!

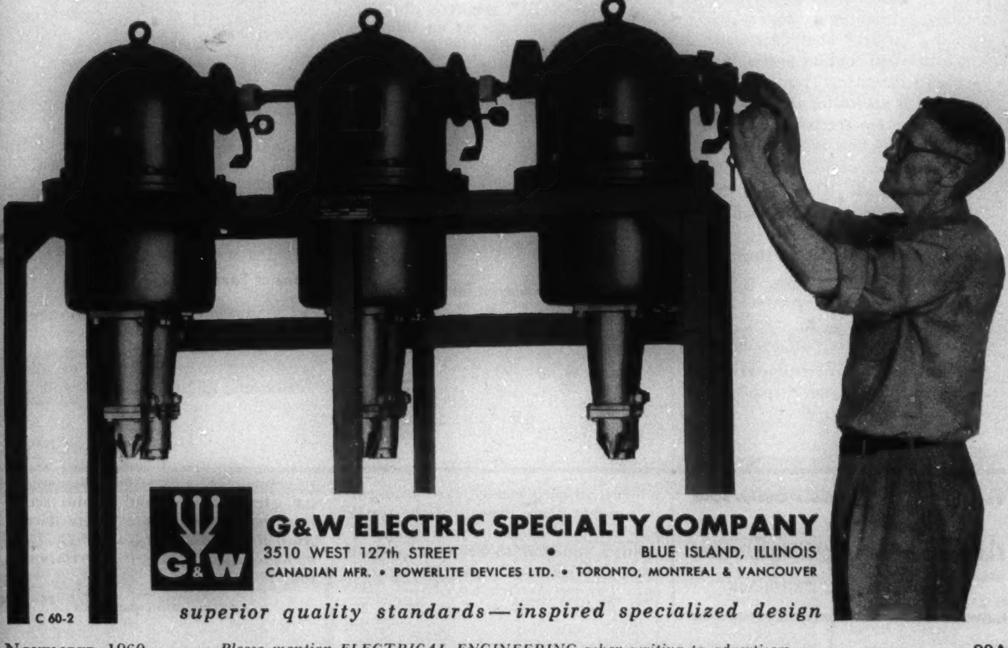
G&W Type FC72, 15 kv Oil-Fuse Cutouts have full 110 kv BIL and high interrupting ability for today's distribution circuits. Impulse withstand level is 110 kv under standard 1½ x 40 microsecond wave and 60-cycle one-minute withstand is 50 kv.

The Type FC72 Cutout can interrupt 7000 amperes asymmetrical (4200 amperes symmetrical) on single-phase operation at 13.8 kv, or 100,000 kva, symmetrical, on three-phase applications. Continuous-current rating is 200 amperes. It can break load currents up to 300 amperes where power factors are 50% or higher and can break magnetizing and load currents of 100 amperes at power factors of 20% or less. Metal-to-metal flanged surfaces with retained gaskets and a heavy wall dome area make this device applicable for use in hazardous locations.

The new G&W 15 kv Cutout is safe, simple to install, easy to operate, and requires little maintenance. In-line construction with operating shaft running horizontally through the cutout dome makes possible coupling of gang-operated cutout shafts in a straight line. Operating handle rotates beyond dead center to lock both "On" and "Off" positions. The interrupter unit with fuses and replaceable switch contacts is raised into the dome above the oil when the cutout is switched to the "Off" position. They are accessible when dome is swung back on its hinge. Dome cannot be opened while switch is in the "On" position.

Repeated tests of the G&W Type FC72 Oil-Fuse Cutout show it will operate five times at full interrupting rating before inspection or replacement of oil is needed.

Contact your G&W representative for complete information, or send for Catalog CC.



G&W

G&W ELECTRIC SPECIALTY COMPANY

3510 WEST 127th STREET • BLUE ISLAND, ILLINOIS
CANADIAN MFR. • POWERLITE DEVICES LTD. • TORONTO, MONTREAL & VANCOUVER

C 60-2

superior quality standards—inspired specialized design

Environmental conditioning
for fire control systems

AiResearch integrated environmental conditioning of aircraft fire control systems achieves high effectiveness while reducing space and weight requirements.

Representative of AiResearch progress is this air-to-air environmental conditioning package which uses the integral heat exchanger and cold plate cooling unit as the base and mounting frame of the pressurized enclosure for the fire control system transmitter. Net weight of this unit is 9.5 lb. with a heat rejection of 425 watts.

This example illustrates the important economies which can be achieved when AiResearch is contacted early in the design stage of electronic systems.

Environmental conditioning equipment has been produced for the following electronic systems:

Detection · Communication · Control · Ground Support · Guidance

Write for literature today.

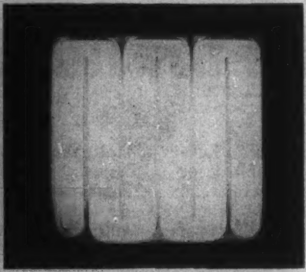
THE GARRETT CORPORATION
AiResearch Manufacturing Division
Los Angeles 45, California

New & Improved Products

(Continued from page 28A)

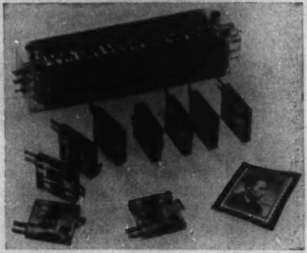
Fluorescent Light Panel . . .

This flat, rectangular fluorescent lamp represents a distinct departure from the usual straight line tube. Only 1½ inches thick, the lamp is actually a labyrinth of passages sealed in a thin glass block. The electric discharge travels this winding path to produce a broad area of light. Designed for modular installations, each 12-inch-square lamp will be rated at 40 to 50 watts that will produce considerably more light than a 100-watt incandescent bulb. *Westinghouse Electric Corp., Bloomfield, N. J.*



Magnetic Shift Register . . .

These wafer-like, magnetic shift register elements operate at an information rate of 100 kilocycles per second at a peak shift pulse power of only 0.1 watts. Similar serial driven, gated transfer shift register circuits are being designed for use at information rates up to 500 kc. Each element stores a binary bit and can be assembled in modules up to 10 elements per inch. All components in each element are arranged in a single plane instead of the usual 3-dimensional assembly, permitting the shifting function to be accomplished with a single turn on each magnetic core. *General Electric Co., Heavy Military Electronics Dept., Syracuse, N. Y.*

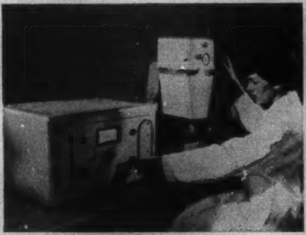


Shipboard Computer . . .

The speed and saturation with which an enemy could launch an attack imposes an urgent need for this ruggedized computer to correlate data into a clear picture of the tactical situation. Measuring only 3 by 3 by 6 feet, the machine is basically a general-purpose stored-program computer with high-speed random access memory. Input data from radars, sonars, radio, and IFF counter measure systems, as well as human sources, are fed into the machine. The resulting output provides identity, size, location, detection, tracking, and speed. Rapid communications between computers on each ship enable the entire task force to operate as one huge ship. *Remington Rand Univac, Univac Park, St. Paul 16, Minn.*

Ultrasonic Impact Grinder . . .

Designed for precision machining semiconductors, and other electronic components, model *V-333* features the first air-cooled 300-watt magnetostrictive transducer ever used for machine tool operations. Not only will this eliminate bothersome plumbing arrangements, but it also provides continuous operation by doing away with down-time cooling often required for ceramic transducers. *Raytheon Co., 1415 Providence Tpke., Norwood, Mass.*



Impact Tester . . .

Up to 3,000 g's may be developed with this pneumatic-powered machine for shock-testing small electronic components. The machine handles specimen loads up to 30 pounds and can produce various shock pulses with an impact velocity up to 192 inches. Features include 1-hand carriage height control adjustment, automatic brake, recycling selector, pressure valve setting for g-level desired, and 2-hand actuation requirement as a safety factor. *Avco Research and Advanced Development Div., 201 Lowell St., Wilmington, Mass.*

(Continued on page 32A)

NIAGARA

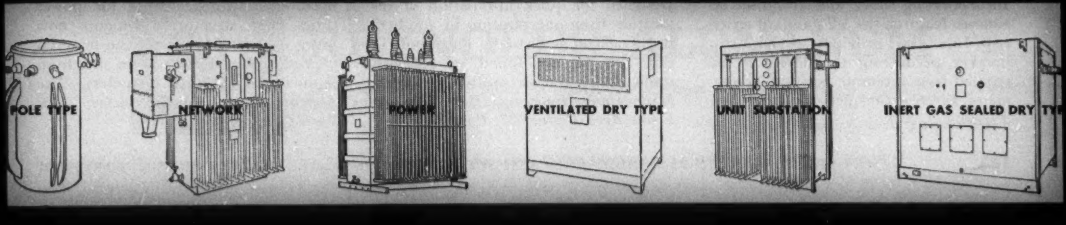
TRANSFORMERS

"You can count on Niagara. Really cooperative. They've never let us down."

Sensitive to the needs of its customers, Niagara has proved its flexibility time and time again in scheduling urgent deliveries. Doing the "impossible" is not uncommon in this organization. Close, personal, *friendly* attention is uppermost. Even shipments are planned to minimize unloading costs.

Built in accordance with established standards or to specified requirements, Niagara Transformers cover practically every service through 10,000 kva, 69,000 volts. Write for Bulletin 139. Niagara Transformer Corp., P.O. Box 23, Buffalo 25, N. Y. Representatives in principal cities.

"There they are . . . we'll have power as scheduled."


POLE TYPE
NETWORK
POWER
VENTILATED DRY TYPE
UNIT SUBSTATION
INERT GAS SEALED DRY TY

New & Improved Products

(Continued from page 30A)

Trace-Recorder . . .

Recent announcement of an 8-channel trace recorder marks the entry of this well-known company into the ranks of industrial recording manufacturers. Features include a bandwidth frequency 40 to 100% wider than was heretofore found practicable in a direct-writing recording instrument. Furthermore band-amplitudes are nearly six times higher than those previously attained. Another feature is a stylus that can be driven up to 70 mph without distortion or impairment of the trace. *American Optical Co., Buffalo 15, N.Y.*

Classroom Demonstrator . . .

With this device, the basic principles of electronics from fundamental circuits to radio, television, and radar can be taught visually. Consisting of a 3- by 5-foot breadboard on a mobile stand, the demonstrator can be assembled and studied circuit by circuit. Operational equipment includes a large classroom-size meter, picture tube and housing, and vacuum-tube voltmeter. Components are connected or disconnected by a new type of device which requires no soldered joints. *Transvision Electronics, Inc., 460 North Ave., New Rochelle, N.Y.*

Heavy Duty Switch . . .

One unusual feature of this safety switch is the removable plate bearing the switch and fuse elements, making installation and wire pulling much easier. Available in NEMA 12 and 1A enclosures, fusible or non-fusible apparatus provides service from 30 through 600 amperes, 240 and 600 volts a-c and 250 volts d-c. *Continental Electric Equipment Co., Box 1055, Cincinnati 1, Ohio.*

Subminiature Circuit Breaker . . .

This commercial version of a military model hydraulic-magnetic circuit breaker is little more than the size of a matchbox and weighs but 1½ ounces. Incorporating shock and vibration resistance features, the VP standard series-trip line also provides a shunt-trip breaker permitting the device to be tripped from a remote position. *Heinemann Electric Co., 236 Magnetic Dr., Trenton 2, N.J.*

Flood Light . . .

A new compact light source for 8-mm home movie makers provides the same effective light with one lamp as an 18-inch bar combination containing four R-30 photoflood lamps. The Sun Gun uses a halogen lamp in a 2¾-inch reflector attached directly to the camera. Drawing 650 watts compared with 1,200 watts for four R-30's, the lamp is balanced for 3,400 degrees Kelvin, allowing filter-free operation with Type A color film as well as black and white. *Sylvania Electric Products Inc., 730 Third Ave., New York 17, N. Y.*

Insulator . . .

This "California" fog type suspension insulator was designed for use in problem areas of heavy contamination where natural cleaning is inadequate, and artificial washing is a scheduled requirement of line maintenance. The triple petticoat design provides an 18-inch leakage distance while the deep-cut, gently curved corrugations catch the wash water and swirl it around the insulator to flush and clean the entire surface. *Lapp Insulator Co., Inc., Le Roy, N. Y.*

Airborne Weather Radar . . .

Weighing 50 pounds, this latest airborne radar is capable of covering the general sky area up to 150 nautical miles with a stabilizing antenna system. Pulse modulated in the X-band frequency range, the *WP-103* contains 73 transistors and 8 tubes drawing only 320 watts a-c. The antenna makes a 120-degree sweep with 60 scans per minute and can be tilted up or down 15 degrees. *Collins Radio Co., Dallas 21, Texas.*

Infrared Traffic Detector . . .

Measuring less than 9 inches square and weighing only 18 pounds, this new traffic detector uses infrared to detect and count moving vehicles. In operation it is positioned so that the infrared beam projects downward onto the traffic lane and is reflected back from the pavement to the receiving lens. When vehicles break the beam, they are detected and counted. Designed for quick installation or relocation from one position to another, the Traffitrol is virtually foolproof. It can also be positioned to regulate traffic lights on a multilane street. *Minneapolis-Honeywell Co., 5200 E. Evans Ave., Denver 22, Colo.*

Power Regulator . . .

Power supplies rated from 100 watts to 50 kv can be regulated automatically with this versatile control. For use in both a-c and d-c output, regulation is available from zero to any desired voltage and from ±3% to any degree of regulation. Visual presentation of the percent of accuracy reached and voltage set makes turning of screw head rheostats and range guessing unnecessary. *American Rectifier Corp., 95 Lafayette St., New York, N. Y.*

Colored Cable . . .

Constructed with an outer cover of yellow neoprene, a new cable manufactured by Western Insulated Wire Co. will be useful where a high degree of visibility is needed to keep it from being inadvertently run over by heavy construction equipment. In permanent wiring installations the yellow-jacket will also make it easier to trace a specific circuit. The colored cable has the same properties as black neoprene-jacketed wiring. *E. I. du pont de Nemours & Co., Inc., Wilmington 98, Del.*

Alarm . . .

An infrared light source provides the invisible detection beam for this new burglar-intruder alarm. Transmission may be either straight line or around corners with mirrors. Called Lyne-O-Larm, the units have sealed-beam projector lamps, use printed circuits, and are fully transistorized. Operating on 110 volts a-c, they contain a standby battery power supply that takes over when normal power fails. *Walter Kidde & Company, Inc., Clifton, N. J.*

Alloy . . .

A new precipitation-hardening alloy composed of copper, lead, nickle, and phosphorus called Leaded Nickle Copper 831, possesses combined properties of high corrosion resistance, high tensile and yield strength, high electrical conductivity, and free machining quality. While the full potential for this material is still being developed, its inherent properties would suggest such end uses as electrical contracts, connectors, control elements for power tubes, and structural elements now using copper. At present, the material is produced in round rod, in sizes from 3/32-inch to 1¼-inch diameters. *The Anaconda Co., 25 Broadway, New York 4, N. Y.*

ELECTRICAL EQUIPMENT

reduces weight, cuts costs

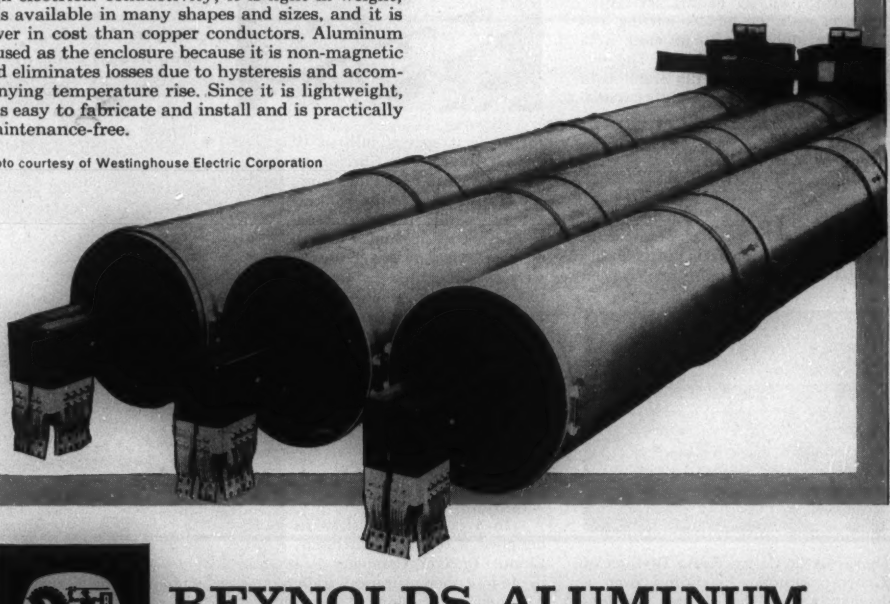
Regardless of whether you purchase or manufacture electrical equipment, aluminum's unique combination of advantages can be of value to you. Some of these advantages are: low cost, minimum maintenance, easier installation, attractive appearance, high electrical conductivity, light weight, resistance to corrosion, high thermal conductivity, strength, ease of fabrication, good availability and high scrap value.

Reynolds engineers are available to help translate these advantages into better products for the electrical industry. Contact your nearest Reynolds office or write *Reynolds Metals Company, P. O. Box 2346-ER, Richmond 18, Virginia.*

Aluminum in Isolated Phase Bus

Aluminum offers both the user and the manufacturer many advantages in isolated phase bus systems. As the bus conductor aluminum offers high electrical conductivity, it is light in weight, it is available in many shapes and sizes, and it is lower in cost than copper conductors. Aluminum is used as the enclosure because it is non-magnetic and eliminates losses due to hysteresis and accompanying temperature rise. Since it is lightweight, it is easy to fabricate and install and is practically maintenance-free.

Photo courtesy of Westinghouse Electric Corporation



REYNOLDS ALUMINUM

Watch Reynolds new TV show "Harrigan & Son", Fridays; also "All Star Golf", Saturdays—ABC-TV.

Industrial Notes...

Baker Perkins, Inc.
Saginaw, Mich. . .

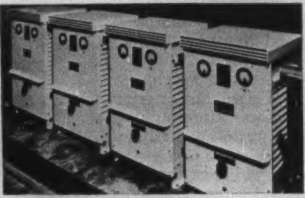
A newly developed system for mechanizing formulation and dough mixing in specialty product baking operations has been installed at the Hillington (Glasgow, Scotland) biscuit bakery of William MacDonald & Sons Ltd. by Baker Perkins Inc. Benefits of the new system include lower operating costs, reduced waste, and a new high in sanitation level. The system is said to represent a new concept of handling and storing liquid ingredients, including fats and chocolate in bulk. Materials are introduced into the dough mixers in the correct sequence, with the mixers starting and stopping automatically to meet individual recipe requirements. The five specialized products of the MacDonald bakery are produced by the system using 22 fewer persons than previously.

General Motors Corp.
Kokomo, Ind. . .

A defense contract connected with the Minuteman Missile program in establishing and operating a reliability program for power transistors has been signed by the Delco Radio Division of General Motors. Extending over a lengthy period, the contract provides for exhaustive testing of some 75,000 Delco Radio power transistors. Aim of the program is to produce power transistors which will achieve a success rate of 99.997%. This means that a single transistor could be expected to have a lifetime of 40,000 years. An ICBM, the Minuteman is a 3-stage solid-propellant ballistic missile which will represent a major economy in missiles due to its simplicity, reliability, and operation. As part of its special equipment, Delco Radio has constructed this testing device which automatically checks eight transistor parameters and records the information on IBM cards. The machine can check a parameter per second. Thus, a rack containing 20 transistors can be fully checked out electrically in the machine and the 320 measurements recorded on cards in approximately 3 minutes.

Christie Electric Corp.
Los Angeles, Calif. . .

In what is reputed to be the largest single installation of its kind in the world, the city of Los Angeles has selected 14 Christie arc lamp rectifiers for use in its new $6 million Memorial Sports Arena. The Christie Rectifiers are designed to feed a maximum of 150 kw of d-c power to the banks of super arc lamps that line the arena's overhead circle of suspended catwalks. The type *ME4* lamps being used as spots were manufactured by Genarco, Inc., of Jamaica, N. Y., to utilize a maximum capacity of 130 amperes at 72 volts. To provide any given lighting effect at any point on the huge 130,000-square foot arena floor, each Christie arc lamp rectifier feeds a continuous capacity of 140 amperes at 80 volts.



I-T-E Circuit Breaker Co.
Philadelphia, Pa. . .

In a campaign to show its newly designed 4,160-volt switchgear, I-T-E Circuit Breaker Company is sending its 44-foot demonstration trailer on a nationwide, year-long "door-to-door" tour. Two-hour sessions given by field office representatives at each location will consist of the showing of an 18-minute sound film, a complete demonstration of the equipment, and a question-and-answer period. Arranged in meeting-room style, the interior of the trailer pictured here is outfitted with 18 chairs, a film projector, screen, back-lighted color transparencies of the equipment's components, and an actual circuit breaker and switchboard. The trailer is air-conditioned, carries its own generator to power the electrical devices, and has coffee and cold-drink dispensers. The redesign of the metal-clad equipment incorporates compact design; closed-door horizontal drawout; stored-energy closing; a new concept of arc extinction known as the ironless blowout coil; and maximum safety and 1-man maintenance.

Douglas Aircraft
Long Beach, Calif. . .

This giant Drivamatic Riveter at the Douglas Aircraft plant is controlled through the use of a TelAutovision camera installed by the TELautograph Corporation. Working on the fuselage assembly of a DC-8 Jetliner, the operator (*seated*) views the entire operation through a 17-inch TELautograph monitor connected to a camera located in a blind position behind the fuselage panel where the rivet ram is located. He can see if the machine is out of alignment with the rivet holes and adjust it manually, if necesary. While the entire operation is tape programmed, the television viewer assures absolute alignment.

(Continued on page 46A)

More power for expansion supplied with USS Tiger Brand Armorlokt Cable over unique suspension bridge

This suspension bridge was built especially to carry high-voltage electrical cables from the power plant to mill at the Ohio Works of United States Steel in Youngstown. The old underground system has become inadequate and to replace it with a new underground system would have been more costly and would have disrupted mill operations.

The largest of the several cables has 500,000 C/M conductors and is 3¾ inches in overall diameter. All are insulated with Amerzone B (Butyl) rubber and protected with interlocked armor.

Armorlokt cable was used for utmost reliability. Failures of power distribution are costly, and represent production losses. This Armorlokt construction offered maximum mechanical protection and electrical reliability with the added "Plus" of complete flexibility of the finished distribution system.

Advantages of open construction. Compared to an underground conduit system, the original cost was considerably less, it provided easy access to the cables for future changes and maintenance and the space on the bridge was large enough to carry double the number of cables for future expansion.

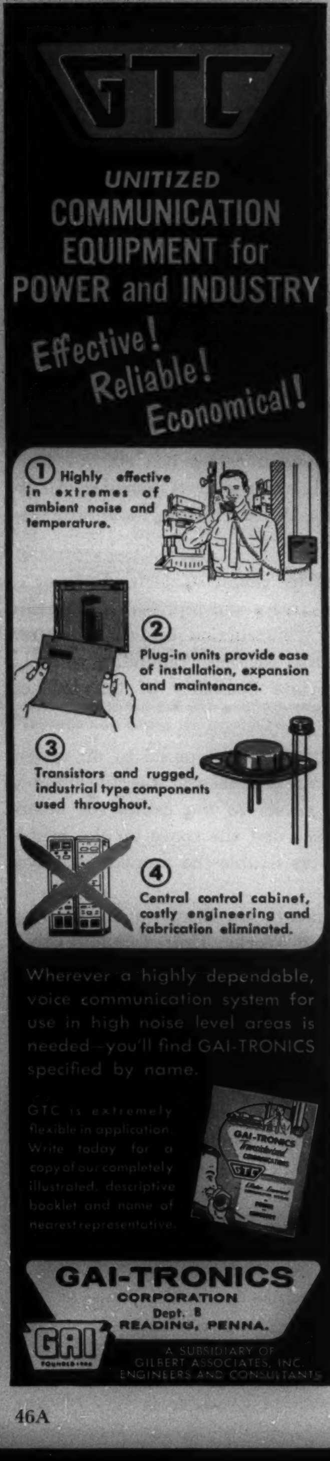
The system was planned by the Electrical Engineering Department of the Ohio Works, United States Steel, of which Mr. M. J. Burger is General Supervisor.

For complete information on USS Tiger Brand Armorlokt Cable, write American Steel & Wire, Dept. 0431, 614 Superior Ave., N.W., Cleveland 13, Ohio.

USS, Tiger Brand, and Armorlokt are registered trademarks

A standard cable for every special job • Asbestos Wire and Cable • Mold-Cured Portable Cord • Shovel & Dredge Cable • Paper & Lead Cable • Varnished Cambric Cable • Interlocked Armored Cable • Special Purpose Wire & Cable • Aerial, Underground and Submarine Cable

◀ **Suspension bridge** carrying six USS Tiger Brand Armorlokt Cables out in the open for easy access.



GTC

UNITIZED COMMUNICATION EQUIPMENT for POWER and INDUSTRY

Effective! Reliable! Economical!

① Highly effective in extremes of ambient noise and temperature.

② Plug-in units provide ease of installation, expansion and maintenance.

③ Transistors and rugged, industrial type components used throughout.

④ Central control cabinet, costly engineering and fabrication eliminated.

Wherever a highly dependable, voice communication system for use in high noise level areas is needed—you'll find GAI-TRONICS specified by name.

GTC is extremely flexible in application. Write today for a copy of our completely illustrated, descriptive booklet and name of nearest representative.

GAI-TRONICS CORPORATION
Dept. B
READING, PENNA.

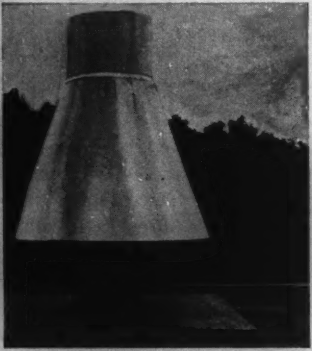
A SUBSIDIARY OF GILBERT ASSOCIATES, INC.
ENGINEERS AND CONSULTANTS

Industrial Notes

(Continued from page 42A)

Melpar, Inc. Falls Church, Va. . .

Melpar, Inc., has delivered 23 beacon antenna systems to Collins Radio Company for use with the communications subsystem being supplied for the manned orbital Mercury space capsule, developed by McDonnell Aircraft Corporation. The antenna systems provide circularly polarized, omnidirectional radiation coverage which is optimum for reliable lock-on of ground-based tracking antennas. Forming part of the missile or space-vehicle skin, the electromagnetic antenna windows are transparent to radio signals, yet can stand the extreme heat of re-entry into the atmosphere. Designed to withstand surface temperatures of 5,000 F (approximately half the temperature of the sun's surface) for several seconds, and 1,500 F for longer periods, the systems include both C-band and S-band antennas, each antenna consisting of a circularly polarized helical radiator embedded in fused quartz dielectric. This high-temperature low-loss dielectric reduces size, minimizes voltage breakdown, and provides thermal shielding, and a transmission window.



Tennessee Eastman Co. Kingsport, Tenn. . .

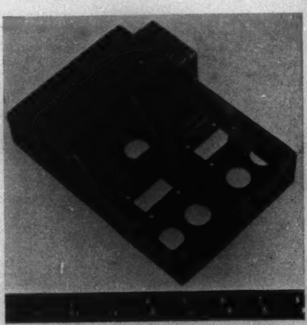
Tennessee Eastman Company's research program has been expanded through the creation of a new company, Eastman Research A.G., a Swiss corporation with offices and laboratories located in Zurich. Facilities in Zurich for the new company are to be ready for occupancy in early spring of 1961. Eastman Research A.G. will be directed primarily toward fundamental or basic research in the fields of polymer chemistry and physics, catalysis, and synthetic organic chemistry.

McGraw, Edison—N.J., Standard Oil—Ind. . .

McGraw-Edison Company and Standard Oil Company have undertaken a project for joint research and development on fuel cells. The initial 2-year agreement calls for combining know-how in their respective fields of the Thomas A. Edison Research Laboratory division of McGraw-Edison at West Orange, N. J., and Standard Oil's research and development department at Chicago, Ill., and Whiting, Ind. The joint project is directed at finding a practical and economical method for oxidizing hydrocarbon, alcohol, or hydrogen as fuel for the cell. A few experimental energy cells already have been developed, but none has been practical enough to meet the requirements for using a cheap fuel that will provide the required power output for commercial use. McGraw-Edison Primary Battery Division has been producing a semifuel cell for over 10 years. Known as their Carbonaire battery, this cell uses zinc and air as fuels to generate electricity directly.

Arwood Corp. New York, N.Y. . .

This intricately shaped part is a housing unit used in a missile. Formerly, it took a total of 2 man-months to machine the parts and then solder them together. Designed by Sanders Associates, Inc., of Nashua, N. H., the part is being investment cast at the Tilton, N. H. plant of the Arwood Corporation, where it is produced by the relatively new ceramic shell investment casting process, cutting machine time to 1 week. The flexibility of design, which permitted casting of proved-out portions of the part, and experimental machining of other portions proved invaluable in making possible the saving in cost and time through the investment casting process.



(Continued on page 50A)

CURRENT FOLLOWS LOW RESISTANCE PATH THROUGH SOUTHERN STATES' BRAIDLESS AIR SWITCHES

Southern States has solved the big problem of providing efficient current transfer in high pressure, braidless side-break air switches. A unique design overcomes any question of reliability in the two current-carrying swivel assemblies inherent in this type of switch.

As a result, in the new Southern States Type 57L and Type GG you can now be assured of low resistance through each swivel assembly, adequate capacity for short circuit currents, and freedom from corrosion and contamination.

This is accomplished by the four-piece swivel units* consisting of carefully machined terminal and blade castings, hinge pin, and pressure clamp—securely bolted together so that the pressure clamp and terminal casting fit into deep, matching grooves on the hinge pin. The silver-plated grooves provide a natural barrier to foreign matter, act as a stable bearing surface for the terminal, and furnish a liberal contact area. The assembly is permanently sealed with a non-aging lubricant.

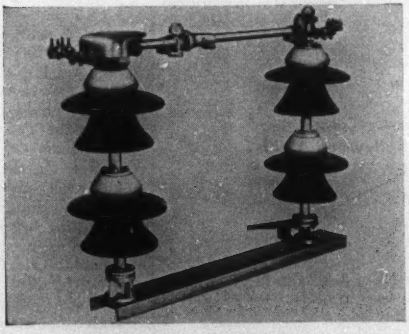
The hinge pin and terminal casting are kept under high pressure by a stainless steel coil spring (insulated by a nylon spacer) to establish the most efficient current interchange point.

The entire assembly, although under high pressure, rotates smoothly—without binding or wedging. It operates satisfactorily under short circuit conditions and well within the limits defined by NEMA for continuous current performance.

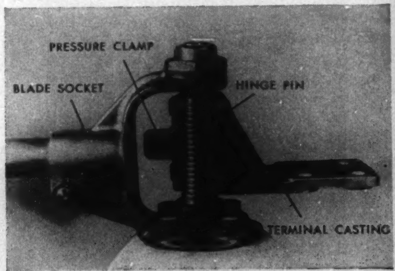
AMPLITACT® contacts are added assurance of contact performance under extremely high fault currents.

For complete details on these new braidless switches, contact your Southern States representative or write directly to us.

*Toggle point of 57L switch blade uses modified version of this assembly.



Type 57L braidless side break available in voltage ratings from 7.2 kv – 161 kv and continuous ratings of 600 and 1200 amperes.



SWIVEL ASSEMBLY—CUTAWAY VIEW

The GG uses the swivel assembly shown as the pivot on both rotating insulators. The 57L uses an identical assembly on its rotating insulator and the same construction principle at the toggle point of the 57L blade.

SOUTHERN STATES EQUIPMENT CORP.

HAMPTON, GEORGIA

IN CANADA

Industrial Notes

(Continued from page 46A)

TELautograph Corp.
Los Angeles, Calif. . .

TELautograph Corporation has been notified by American Telephone & Telegraph Company (AT&T) that for the first time message rate telewriter service will be permitted over telephone lines on a local and long-range basis, thus making it possible to send a hand-written message instantaneously by telephone. The new service utilizes an analog subset, which can be attached to an ordinary phone by AT&T. The TELautograph Telewriter can be connected to this. Telephone subscribers will be charged for written messages on a basis similar to that used for regular calls. It is expected that both the service and the analog subsets will be made available by the telephone company in the fall. The equipment will make it possible for a telephone subscriber to write a message in his own handwriting, concluding with his own signature, after a phone conversation from any point in the United States to any other point. The system promises to be an invaluable aid in transmitting diagrams, signing contracts, etc.

Ford Motor Co.
Newport Beach, Calif. . .

The U. S. Navy's Bureau of Naval Weapons has awarded a contract to Ford Motor Company's Aeronutronic Division (Aeronutronic) to investigate the feasibility of an under-sea warfare device originally developed by Aeronutronic with company funds as a proprietary item. Under terms of the contract, amounting to $175,000, Aeronutronic will carry out further development, prototype fabrication, and preliminary operational testing of the device for the Bureau of Naval Weapons. Details of the device are classified.

Midwest Piping Co.
St. Louis, Mo. . .

Midwest Piping Company has contracted to fabricate and erect the piping system for a new 250,000-kw unit of Cleveland Electric Illuminating Company's Lake Shore Station on Lake Erie, in Ohio. The piping firm has already begun engineering work on the $2 million project, which will include high-pressure piping, low-pressure piping, and instrumentation. Operating conditions will be 2,520 psi at 1,000 F. Final work is scheduled for completion early in 1962.

Aluminum Co. of America
Pittsburgh, Pa. . .

A new research laboratory to serve the electrical industry will be built in Fort Wayne, Ind., for Rea Magnet Company, Inc., subsidiary of Aluminum Company of America. The laboratory will be built on a recently acquired tract of land southeast of Fort Wayne, about 2½ miles from the company's Fort Wayne works and main office location. A tentative schedule for the project calls for completion of the laboratory in 1961. Activities of the new laboratory will include improvement and development of insulations for copper and aluminum round magnet wire, investigation of insulations for aluminum sheet and foil strip conductor, and development of techniques and engineering data for manufacture of coils from round wire and strip conductors.

Alden Co.
Westboro, Mass. . .

The Meteorological Division of the U. S. Navy Bureau of Weapons has ordered 150 advanced-design high-speed facsimile weather map recorders from the Alden Electronic & Impulse Recording Equipment Co., Inc. The recorders will be installed at shore-based weather stations of the Navy and Coast Guard, and will receive the weather map transmissions sent out by the Weather Bureau over the National Facsimile Weather Map Network. The new equipment will replace presently used recorders, increasing recording capacity to 120 scan lines per minute. The Weather Bureau will begin transmissions at the new rate on December 15, using Alden continuous flat-copy facsimile scanners.

The Bendix Corp.
North Hollywood, Calif. . .

A new low-cost Bendix-marine automatic pilot has been modified to incorporate advanced compass engineering formerly available only in more expensive systems. The rugged model *125B* pilot will appeal particularly to boat owners wanting simplified operation, according to The Bendix Corporation's marine department. Its magnetic compass unit utilizes a new-type floating card and photocell conductive element. The system includes the binnacle, steering motor with manual clutch, and control unit. The control box includes the on-off switch, weather sensitivity control and provision for a remote course-changing and dodging accessory.

Thompson-Ramo-Wooldridge
Beverly Hills, Calif. . .

The Thompson-Ramo-Wooldridge Products Company has changed its name to TRW Computers Company. The company will continue to function as a computer division of Thompson Ramo Wooldridge Inc. Headquarters will remain in Beverly Hills. TRW Computers will assume the responsibility in the commercial field for marketing, applications engineering, installation engineering, programming, and maintenance of digital equipment developed by the Ramo-Wooldridge Division. Sale of large developmental systems to military agencies will continue to be the responsibility of the Ramo-Wooldridge Division.

Prestoseal Mfg. Corp.
Long Island City, N.Y. . .

The Prestoseal Manufacturing Corporation has been given the Government's General Service Agency award in the microfilm field. The award, known as FSC Group 67 Photographic Equipment, Part IV Item 21-1 and Item 21-5, carries with it the authorization to all Government agencies which may have use for microfilm or tape splicing equipment to employ the services of Prestoseal when buying such equipment. Covered are Microfilm and Magnetic Tape Splicer Series 100.1 to 100.7 (16 mm to 70 mm), as well as an adapter for intermix splicing of different base materials.

Potter Instrument Co.
Plainview, N.Y. . .

A high-speed 26-column, numeric printer made by Potter Instrument Company has been selected for use in the Air Force AN/GJQ-9 automatic ground checkout system for the Douglas Skybolt missile. Bendix Support Equipment, the Teterboro, N. J., section of the Bendix Corporation, is prime contractor for the system. The Bendix-built checkout equipment will be used at depots and launching sites to check launching readiness of the Skybolt. System requirements called for a highly reliable printer, in an unusually small package and able to operate under extreme environmental conditions. Potter's model *3333* printer, which met these specifications, is completely transistorized, operates at speeds up to 600 lines per minute, and has a self-contained paper supply and take-up. Serving as one of the system readouts, the Potter *M3333* gives a permanent, printed record of every missile test as well as go-no-go indications.

(Continued on page 56A)

POSITIONS OPEN

PROFESSOR OR ASSOCIATE PROFESSOR of Electrical Engineering to teach and do research in the field of communications. Should have Ph.D., teaching and research experience. Write Box 56.

GRADUATE ASSISTANTSHIPS are available at a university in the Southeast for September, 1961. Assistants may obtain the Master of Science degree in Electrical Engineering in twelve months. Tuition free. Write to Box 99.

SALES & DESIGN ENGINEERS: Top notch positions for Electrical Engineers in sales and design field at expanding manufacturer of induction melting and heating equipment. Metallurgical background helpful. Positions involve some travelling from home office near Philadelphia. Liberal salaries, bonuses and profit sharing reflecting the abilities of the men we seek. Send photos and resumes in complete confidence. Inductotherm Corporation, 412 Illinois Avenue, Delanco, New Jersey.

PERMANENT OPENINGS for Electrical Engineers and Mechanical Engineers experienced in the design of hydroelectric projects. Prefer graduate registered engineers with 4 to 10 years experience. Career opportunities in Denver office of growing organization with excellent employee benefit program. Mail resume to Engineering Consultants, Inc., 1901 South Navajo Street, Denver 23, Colorado.

ELECTRICAL SUPERINTENDENT — LATIN AMERICA. Long established United States firm has outstanding opportunity for Electrical Engineer in its largest Latin American division. Will direct diversified electrical department including power plants, city utilities, telephone system and newly constructed production plants. BSEE plus at least five years' experience required. Knowledge of Spanish helpful but not essential. For full information regarding position, benefits and salary, write in confidence. Please send complete resume including present salary with first letter. Write Box 106.

ELECTRICAL ENGINEER, Graduate, with experience in the utility or a related engineering field for a choice of openings in Substation Design, Transmission Line Construction & Design, System Planning, Distribution Planning, and Communications sections. Starting salary—up to $10,000, depending on qualifications. Location—Midwest. Your inquiry will be held in confidence. Box 108.

TEACHING POSITION IN ELECTRICAL ENGINEERING open to teach machinery and other undergraduate subjects. Also, some graduate courses at night. MS or Ph.D preferred. Appointment February or September. Write to Head, Electrical Engineering Department, University of Akron, Akron 4, Ohio.

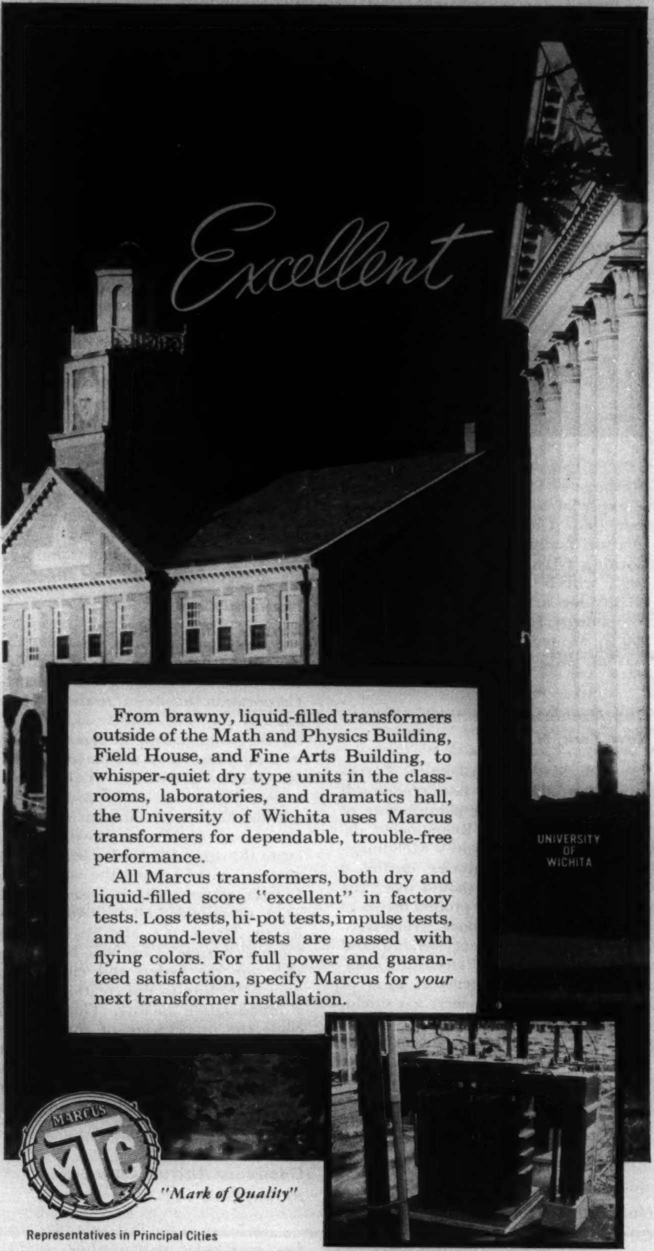
WE HAVE AN important opening for an Engineer. An electrical background is preferred but not necessary, provided he can demonstrate by test report or by reference to associates, that he has a high intelligence quota. The man we are interested in must desire engineering accomplishment rather than administration. That to us means the ability to start with a concept and carry through to the availability of the product in production. Technical support is of course provided, but the responsibilities lie with the engineer. The compensation level of the right man will be in line with the top brackets of salaries paid by the industry. If you are interested, please get in touch with me personally. W. H. Walter, Vice President, Electric Regulator Corporation, Norwalk, Conn.

POSITIONS WANTED

RELAY ENGINEER—24 years of experience in all phases of relay protection for substations, power plants, and transmission facilities. Age 43. Desirous of challenging opportunity. Write Box 102.

COMPUTER ENGINEER, 32, BSEE. Ten years development experience in data handling and digital computers. Complete circuit and logical design on commercial and military computers. Prefer small company, in suburban location, that needs engineering talent. Write Box 105.

ENGINEER — B.S.E.E. — POWER — P.E. — 36, Family, 2 years general utility engineering, i.e. distribution, transmission, board studies, relays, etc.; 8½ years Industrial Power Sales for large electric utility. Complete resume on request. Location open. Box 109.



From brawny, liquid-filled transformers outside of the Math and Physics Building, Field House, and Fine Arts Building, to whisper-quiet dry type units in the classrooms, laboratories, and dramatics hall, the University of Wichita uses Marcus transformers for dependable, trouble-free performance.

All Marcus transformers, both dry and liquid-filled score "excellent" in factory tests. Loss tests, hi-pot tests, impulse tests, and sound-level tests are passed with flying colors. For full power and guaranteed satisfaction, specify Marcus for *your* next transformer installation.

"Mark of Quality"

Representatives in Principal Cities

1500 KVA OIL FILLED TRANSFORMER

MARCUS TRANSFORMER CO., Inc.
RAHWAY, NEW JERSEY

A COMPLETE LINE OF DRY TYPE AND LIQUID-FILLED TRANSFORMERS THRU 5000 KVA

Industrial Notes

(Continued from page 50A)

Corning Electronic Components
Corning, N.Y. . .

Corning Electronic Components has announced plans to build a new plant at Raleigh, N. C., for production of glass capacitors. The 1-story plant will be located on a 32-acre site just northeast of Raleigh, and construction is expected to be completed by summer, 1961. The new facility which will increase manufacturing space in the Corning Glass Works department by 80%, will be Corning's third major facility for manufacture of electronic components. It will contain about 120,000 square feet and employ about 275 persons.

Olin Mathieson Chemical
New York, N.Y. . .

Olin Mathieson Chemical Corporation has adapted a fast, economical welding process to the manufacture of aluminum products. Refinements developed by the company's Metallurgical Research Laboratories during a 2-year study program should make the MIG arc spot welding process useful to makers of aluminum boats, truck trailers, shipping containers, window and door frames, grating, electronic components, and other items. A form of consumable electrode, inert gas shielded, and metal arc welding (MIG: metal, inert gas), the process is expected to result in more rapid production, substantial labor and equipment savings, and improved product appearance, as compared with those attainable with riveting or conventional resistance spot welding.

North American Aviation
Canoga Park, Calif. . .

The National Aeronautics and Space Administration (NASA) has completed contract negotiations with Rocketdyne, a division of North American Aviation, Inc., to develop a 200,000-pound-thrust rocket engine. Work under the contract, valued at approximately $44 million, will start immediately. The contract provides for a 4½-year development and qualification program to advance the hydrogen-fueled engine to proven flight capability. The new engine, designated J-2 by Rocketdyne, may be used in clusters of two or four to power the second and third stages of advanced versions of NASA's Saturn space vehicle. First models will have single-start capabilities, but simple changes later will allow multiple starts during flights. The first version of Saturn will be operational in 1964. Its first stage will be an 8-engine cluster producing 1.5 million pounds of thrust. The second stage will be four 17,500-pound-thrust hydrogen-fueled engines, and the third stage will be two 17,500-pound engines. Advanced Saturns, using new J-2 engines, will follow in the 1960's. The initial Saturn will be able to boost 20,000 pounds into a low earth orbit, or 6,000 pounds on an escape mission. Clustering two J-2's in the advanced Saturn's second stage could increase its weight-lifting capacity by 50%, and a 4-engine cluster would almost double it.

Northrop Corp.
Beverly Hills, Calif. . .

Page Communications of Washington, D.C., a subsidiary of Northrop Corporation, has been awarded a contract by the U. S. Information Agency for the architectural design and engineering phase of an estimated $12,627,000 Voice of America (VOA) International Broadcast facility to be located outside Monrovia, Liberia. The VOA station, when completed, will be similar to the other VOA relay installations now in service around the world. The Liberia station will be used by the VOA to provide relay broadcast service to Africa, the Middle East, and Central Europe. Page will be responsible for the design and engineering aspects leading to the creation of such a broadcasting facility. This will include the preparation of construction drawings and specifications, site surveys, and preparation of procurement specifications for all structural, operating mechanical, electrical, and electronic equipment.

Goodyear Aircraft Corp.
Akron, Ohio . . .

Delivery of the first antennae for a new taxi radar system which enables airport traffic controller to "see and sort" aircraft and ground vehicles even in "ceiling zero" conditions has been made by Goodyear Aircraft Corporation. The firm produced the reflector, support trusses, and pedestal under contract to Airborne Instruments Laboratory, which developed the taxi radar, officially known as Airport Surface Detection Equipment. The reflector, made of Bondolite sandwich material consisting of stretched aluminum faces with an aluminum honeycomb core, can rotate 360 degrees at 60 rpm. Scheduled for installation by the Federal Aviation Agency and the Air Force at major airports throughout the country, the system provides a high resolution "picture" of the entire airfield and surrounding area

Electronic Communications
St. Petersburg, Fla. . .

Electronic Communications, Inc. (E.C.I.) has announced an arrangement with Western Union Telegraph Co. whereby Western Union will market on an experimental basis "Electronic Messenger" facsimile equipment manufactured by E.C.I., which makes the only letter-size facsimile transceiver available today. This new unit can be used alternately as a receiver or a transmitter, and utilizes humidified paper. Western Union will initially purchase 100 Electronic Messenger units, and handle the leasing and servicing of units now being performed by E.C.I. for its customers.

Philadelphia Electric Co.
Philadelphia, Pa. . .

Philadelphia Electric Company has designed and installed four all-aluminum reactor cages at their new Blue Grass Substation. By using aluminum, the utility anticipates service-life cost savings over galvanized steel structures. Another advantage gained is that electrical problems due to the use of magnetic materials in enclosure structures have been eliminated. Built around a frame of aluminum structural members, the enclosure employs a unique extruded aluminum angle member, welded to form panels for front and back sections. Sheets of expanded mesh aluminum are dropped into channels in the extruded angle, and are held in position by crimping the edges of the channel at several points. Cage sides are aluminum sheet. Buses are welded tubular aluminum.

Trade Literature . . .

High-Speed Precision Balances . . .

General purpose high-speed precision balances, designed for small capacity industrial weighing operations of all types, are described and illustrated in bulletin 3414. Series "K" balances utilize the principle of weight by substitution to assure maximum accuracy. Weight readings are indicated with a shadow-edge light projection on a large, direct-reading illuminated dial. Included are complete specifications and operating instructions for these balances. For a free copy of this bulletin or technical assistance with weighing problems, write to *The Exact Weight Scale Co., 541 East Town St., Columbus 15, Ohio.*

Synchro Mounting Instructions . . .

A handy leaflet gives comprehensive details and illustrations on mounting and zeroing all types of synchros and servomotors, and on fixing gears or pinions. Tables specify details for mounting panel drilling, and recommend fixing-screw sizes. Included is a comprehensive parts list from which the ordering reference for any of the accessories may be obtained. Limited to synchro manufacturers, the leaflet will be mailed free of charge to any part of the world by *Muirhead & Co. Ltd., Beckenham, Kent, England.*

Insulation and Ceramics Bonding Charts . . .

Two newly published bonding charts covering most types of ceramic tile and insulation applications show at a glance specifications for bonding practically any combination of materials required. Data is given on insulation of every type as applied to aluminum, aluminum ducts, aluminum foil, asbestos board, brick, drywall (including hardboard), foamed plastic pipe covering, galvanized, paper (asphalt impregnated), paper (rosinized), plaster, plywood, steel, and vinyl. Application of ceramics of all kinds is dealt with in connection with use on gypsum wallboard, unpainted gypsum white coat, painted plaster, keene's cement, gypsum plaster brown coat, portland cement plaster, masonry (brick, concrete, cinder block, etc.), poured concrete, plywood standard grade, plywood exterior grade, cement asbestos board, terrazzo, metal, and existing tile. *Miracle Adhesives Corp., 250 Pettit Ave., Bellmore, L.I., N.Y.*

A-C to D-C Conversion Notes . . .

A new method of a-c to d-c conversion has resulted in the issuance of a technical data sheet, "Applications Notes on AC to DC Conversion," which describes in detail the essential mode of operation and the significant waveforms, both illustrated with diagrams. A functional block diagram, corresponding to the physical hardware used to perform a-c to d-c conversion, is also included. Combining high degrees of accuracy, reliability, and speed, as well as long-term stability, the method is particularly suited to the requirements of automatic instrumentation systems. All solid-state precision amplifiers and semiconductor switches implement the conversion. *Adage, Inc., 292 Main St., Cambridge 42, Mass.*

Secondary Standards For Load Cell Calibration . . .

An 8-page technical bulletin discusses the various types of secondary standards available for force measurement, as well as the reasons for the decrease in the confidence factor as the secondary standard accuracy approaches the accuracy of the primary standard. An installation of a 1,000,000-pound-capacity secondary standard for load cell calibration, with an accuracy of ±0.05%, is explained in detail. For bulletin TD-103, write to *Gilmore Industries, Inc., 13015 Woodland Ave., Cleveland 20, Ohio.*

Flexible Shaft Handbook . . .

The completely revised fourth edition of the S. S. White flexible shaft handbook is now available free of charge to design engineers and potential users of flexible shafts. A simplified approach to the selection of flexible shafting through standard, pre-engineered, or custom-designed flexible shafts is featured among the new data. Other hitherto unpublished data include information on a new, simplified engaging system based on integral formed square drives, and new, improved remote-control and power-drive flexible shafts. The handbook describes in detail the advantages of flexible shafts, their function, successful applications, fundamental information on standard power-drive and remote-control shafts, uses of adapters and other accessories, and a section of tables and statistics. *Dep't P., S. S. White Industrial Div., 10 E. 40th St., New York 16, N. Y.*

Battery Capacity Determination . . .

Users of lead-acid batteries for motive power application in electric industrial trucks will be interested in a 4-page brochure which presents a quick and easy method for determining the capacity of batteries that have been in service for more than 3 years. Three curves are shown which simplify calculations, and three examples of actual tests are given in detail. Request brochure no. GB-1661-A from *Gould-National Batteries, Inc., Trenton, N.J.*

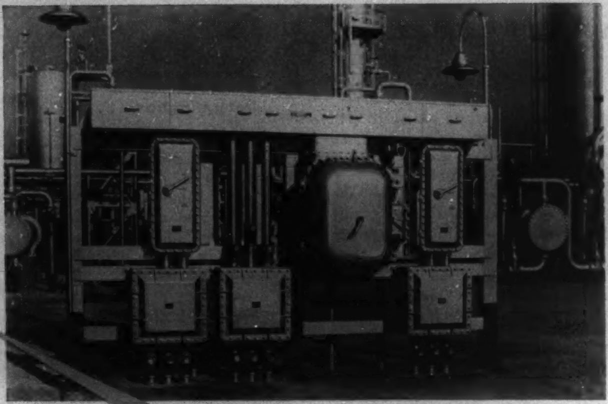
Welded Alloy Manual . . .

A 56-page welding, brazing, and soldering alloy and flux catalog and instruction manual includes physical properties, major uses, detailed application instructions, and the latest techniques for welding, brazing, soldering, cutting, and hardfacing. Charts and tables summarize alloy selection and properties, and products are indexed by major metal use. The manual is designed for the advanced welder or engineer, as well as the beginner. Practical short-cuts, helpful hints, chemical composition, and data on automatic and semiautomatic welding wire are given. Manual welding, brazing, soldering, cutting, and tinning instructions are also included. Designed for maintenance or production welders, design, maintenance, and production welding engineers and foremen, trade school instructors and purchasing agents, the pocket-size manual is also offered in Spanish on written request. *All-State Welding Alloys Co., Inc., 249-55 Ferris Ave., White Plains, N.Y.*

Flashover Slide Rule . . .

A new slide rule chart lists complete string flashover values for all EEI-NEMA and Fog Type suspension insulators. These insulators are identified by type, size, and spacing, as well as by catalog number. The flashover values are arranged so that selecting an insulator and adjusting the slide for the number of units per string gives a reading for all flashover values for that particular string. Flashover values for all suspensions, in strings of 2 to 25 units, are listed on the slide. Attractively printed in two colors on heavy stock, the flashover slide rule is available on request from *Lapp Insulator Co. Inc., Le Roy, N.Y.*

(Continued on page 66A)



296*

296 — *that's the number of switchracks made by Nelson the last four years. A Nelson switchrack is the simple, sure way to save important money on an outdoor assembly of electrical control components. Nelson makes them explosion-proof or water-tight and dust-tight, all with conduit factory formed and assembled, and with all wiring and cable runs installed.** 97% of our switchrack customers come back for additional units when in expansion or modernization programs.

What better evidence of complete satisfaction could be desired?

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BIG ENOUGH TO PERFORM
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Be sure to let your Nelson representative figure your next job. You will find him listed in the Yellow Pages of major city telephone directories.

*** Ask your Nelson man for the facts on some of these installations.*

NELSON *Electric* MANUFACTURING CO.
TULSA, OKLAHOMA
P. O. BOX 5385 NATIONAL 7-5530

Trade Literature

(Continued from page 65A)

Primer for Computing Resolvers . . .

A 16-page illustrated monograph describes the characteristics of computing resolvers, explaining such definitive properties as function error and axis error, and detailing the techniques of measurement. Although computing resolvers may be applied in numerous ways, these basic tests will yield enough data for both system calculation and competitive evaluation. *Theta Instrument Corp., 520 Victor St., Saddle Brook, N. J.*

Electrical Calculations for Resistance Welders . . .

Tables which simplify calculation of the electric power supply required by resistance welders are contained in this 8-page brochure. Factors of electrical demand and duty cycle are tabulated to establish minimum welder transformer kva ratings. Maximum safe rate of operation of a welder can be readily determined by use of these tables, which establish the maximum electrical duty cycle of a transformer under various demand loads. Request bulletin SP-8A from *The Taylor Winfield Corp., 1048 Mahoning Ave., Warren, Ohio.*

Relay Booklet . . .

A recently issued booklet on the adjustment and maintenance of relays contains 8 pages of detailed instructions. Line drawings simplify the correction of relay difficulties for the maintenance man. A section on relay terminology is included. *P. K. Neuses, Inc., 511 N. Dueyer St., Arlington Heights, Ill.*

Electric Utility Bus Duct Data . . .

Application data for electric utility bus duct is contained in this 12-page booklet. The descriptions, drawings, dimensions, specifications, engineering and test data in the publication give specific information needed to lay out, specify, and install this type of bus duct. Electric utility busway was specifically designed to carry excitation currents, but it is also ideal for applications such as battery charging and electroplating. Request application data 30-664 from *Westinghouse Electric Corp., P.O. Box 2099, Pittsburgh 30, Pa.*

(Continued on page 68A)

SOLVING MATERIAL DESIGN PROBLEMS
ELECTRICAL INSULATION

From a cool shave to continuous heat. CDF MICABOND® insulation solved two problems: low cost for tiny commutator V-rings in electric shavers . . . continuous heat in traction motor and generator V-rings and segments for diesel locomotives.

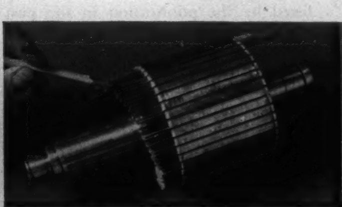
You get the exact physical and electrical properties you want at low cost when you have a wide selection of grades to choose from, plus engineering know-how to help you with your selection.

The many grades and types of MICABOND made it comparatively easy to solve the different insulation problems posed by low cost shaver motors and rugged locomotive traction motors and generators.

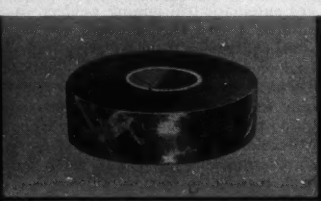
In addition to the MICABOND line, CDF makes the industry's widest range of laminated plastics, vulcanized fibre, and other electrical insulating materials. For MICABOND information, write us for catalog M-59. For other product information, ask for General Folder 60. Or check your Sweet's Product Design file.

CONTINENTAL-DIAMOND FIBRE

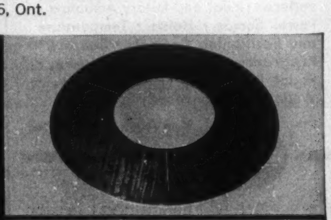
A SUBSIDIARY OF THE Budd COMPANY • NEWARK 86, DEL.
In Canada, 46 Hollinger Road, Toronto 16, Ont.



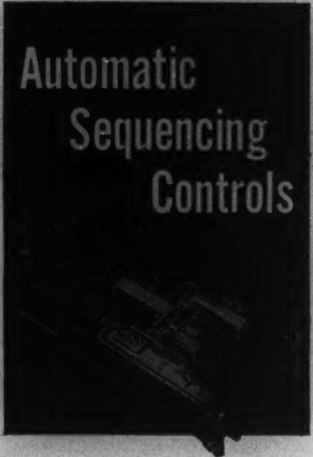
Long-life insulation. CDF MICABOND is used in low-cost slot-cell insulators in motor assemblies.



Flexible. CDF MICABOND tapes provide high heat resistance for many types of electrical windings.



Impact resistance. A reason why MICABOND was used as disc insulators for giant magnetic cranes.



AiResearch's design and manufacturing capability covers many types of automatic sequencing controls such as those for missile ground checkout, controlling drone and missile flight profiles, and automatic elevation and leveling of radar antennas and missiles.

Above is an AiResearch sequence controller for cabin temperature of a jet airliner. It assimilates 25 sensor element inputs and supplies command signals to 18 amplifier channels. Consisting of servo-operated potentiometer cards, cam switch programmer and other electromechanical components, it is another example of AiResearch's over-all ability to design and produce intricate and complicated servo systems.

The most experienced company in the development and production of control systems for airborne and ground use, AiResearch is an industry leader in electromechanical systems and components of all types for aircraft, ground handling, ordnance and missile systems.

OTHER ELECTROMECHANICAL COMPONENTS AND SYSTEMS

AC and DC Motors, Generators and Controls • Static Inverters and Converters • Linear and Rotary Actuators • Power Servos • Hoists • Temperature and Positioning Controls • Sensors • Programmers • Missile Launchers • Radar Positioners • Power Supplies • Williamsgrip Connectors

Your inquiries are invited.

THE GARRETT CORPORATION

AiResearch Manufacturing Division

Los Angeles 45, California

Trade Literature

(Continued from page 66A)

"Meteorology on the Move" . . .

A report published by the Committee on Atmospheric Sciences of the National Academy of Sciences—National Research Council, notes with satisfaction a number of recent undertakings by government and academic institutions in response to previous Committee recommendations, including a first step toward a National Center for Atmospheric Research. The report discusses further steps that are urgently required, chief among which are the rapid development by the National Center of an extensive research and analysis program, and the strengthening of the research program of the U.S. Weather Bureau. *Printing and Publishing Office, National Academy of Sciences—National Research Council, 2101 Constitution Ave., N.W., Washington 25, D.C.*

Microscopic Methods for Particle Sizing . . .

Technical Information Manual 6 has been published for those engaged in air analysis, filtration and purification, and allied occupations. The booklet describes methods of determining particle sizes by using optical or electron microscopes. It tells how to use oil immersion techniques for particle mounting, and describes the use of the eyepiece graticule for sizing and counting. Proper particle measurement methods are also discussed, and the equation for converting particle size by count to particle size by weight is given. *Gelman Instrument Co., 106 North Main St., Chelsea, Mich.*

"Welding News" . . .

Advantages of mash seam welding as a high-speed high-strength low-buildup method of coil joining are described in Vol. 12, no. 1 of this illustrated 6-page publication. Included are engineering specifications and work range of 11 types of special and standard automatic coil joining welders, including mash seam, spot, arc, and lap seam equipment, to meet every industrial requirement.

The bi-monthly pamphlet also contains useful information on automated units performing shearing, welding, and cold rolling operations for users considering joining equipment on anneal, coating, inspection, slitting, and strapping lines. *National Electric Welding Machines Co., 1846 Trumbull St., Bay City, Mich.*

Defense Dep't Engineering Data . . .

A 6-page folder discusses the new standards and specifications of the Defense Department's engineering data micro-reproduction system. Based on speeches by Department of Defense spokesmen before the 1960 convention of the National Microfilm Association, the folder explains the new program in simple, concise terms. Since the system is based upon the use of aperture cards as the standard medium for exchanging engineering data, an illustrated explanation of these cards is included. *Dept. SO-372, Minnesota Mining and Mfg. Co., 900 Bush Ave., St. Paul 6, Minn.*

Gamma Spectrometer System . . .

A 12-page brochure describes an improved spectrometer system for identifying, tracing, and labeling gamma emitting radioisotopes. Known as the *GSS-1*, the system employs a new analytical principle to obtain higher resolution over a wider range of spectra energy than ever before possible. It can analyze emitters within the approximate energy range from soft X-rays to above 6 mev. At the same time, "dark current" background common to other systems is eliminated. Illustrated in the brochure are actual graphs showing the spectra of various radioisotopes. These include colbalt-60, lead-210, cesium-137, radium, uranium ore, euxenite ore, iron-59, chromium-51, and iodine-131. Also included are graphs showing two or more emitters that were analyzed simultaneously. The system consists of a combination linear count ratemeter and transistorized spectrometer circuit, scintillation probe, slave scaler, graphic recorder, and universal shield. Request brochure no. 704 from *Nuclear Measurements Corp., 2460 N. Arlington Ave., Indianapolis 18, Ind.*

"Advanced Materials Technology" . . .

The current issue of this 12-page brochure is a condensed descriptive resume covering the new products listed by the publication in the past 2½ years. Among the products discussed are KT silicon carbide, GRB silicon carbide, silicon carbide foam, Fiberfrax, boron nitride, boron carbide, fused refractories, fused magnesium, zirconium, hafnium, hot pressed alumina, and others. The brochure includes tables, and lists advanced materials literature available upon request. *Advertising Branch, The Carborundum Co., Niagara Falls, N.Y.*

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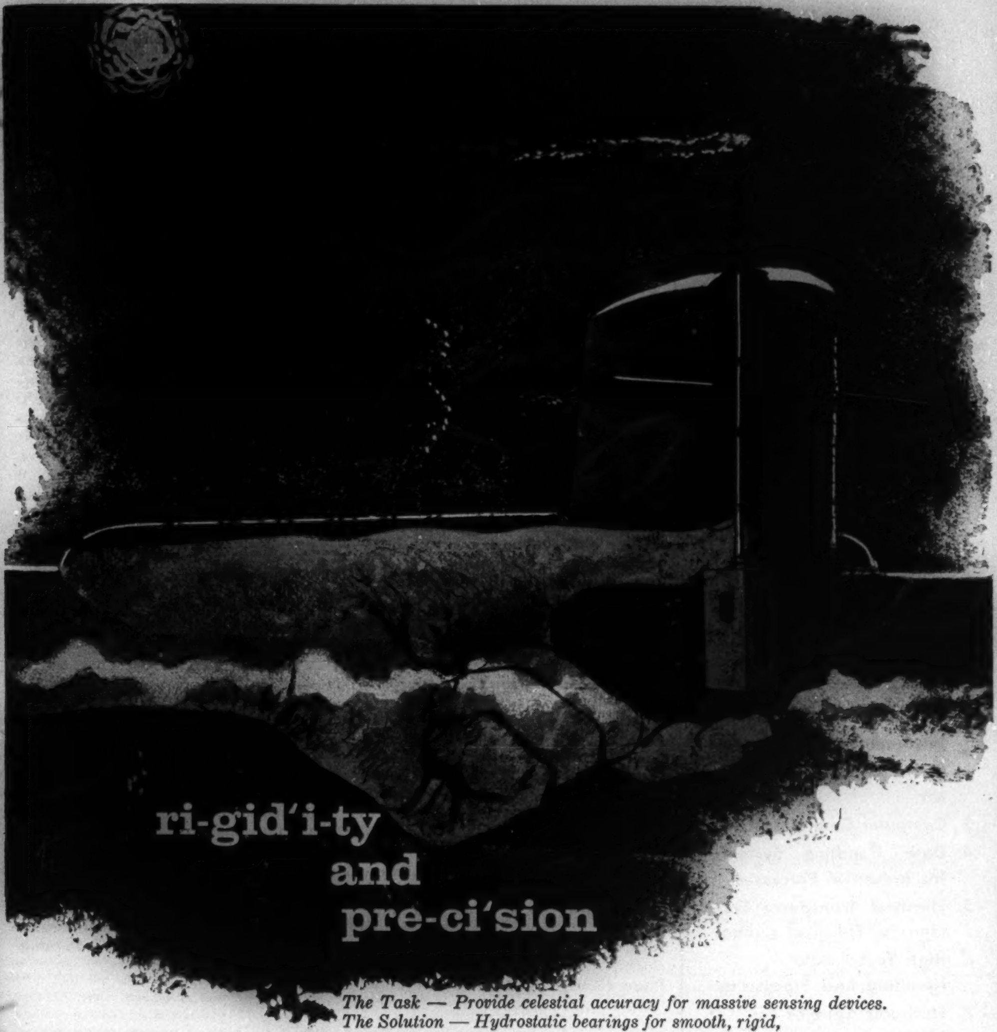

The Task — Provide celestial accuracy for massive sensing devices.
The Solution — Hydrostatic bearings for smooth, rigid, "frictionless" support.

In Polaris submarines and other military applications, these hydrostatic bearings, developed by Nortronics, are particularly suited to virtually frictionless support of a large structure, which can be positioned accurately by a servo system with no unevenness, runout or binding — yet extremely stiff under applied loads.

A NOTE FOR TALENTED ENGINEERS:
We invite your inquiry as to important positions at Nortronics' Precision Products Department. Excellent salaries for qualified men in both our Systems and Component Groups.

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3rd National Conference

ON ANALOG AND DIGITAL INSTRUMENTATION

March 1959

This conference was planned to provide a review of the progress made in instrumentation technology. Publication T-113 is the record of the conference held at Philadelphia, Pa., April 20-21, 1959. Sponsored by the Recording and Controlling Instrumentation Committee of the AIEE, the 279-page publication contains 31 of the papers presented at the meeting which was divided into the following sessions:

1. **Engineering Education for Instrumentation**
2. **Electronic Analog Recorders**
3. **Computer Control Systems**
4. **Data Handling Systems for Industrial Processes**
5. **Electrical Transducer Systems for Electrical Control**
6. **High Speed Data Handling and Processing**
7. **Electronic Systems for Process Control**

Publication T-113 may be ordered for $5.00 from the

Order Department
AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS
33 West 39th Street
New York 18, N. Y.

Trade Literature

(Continued from page 68A)

Optics and Electronics Technical Reports . . .

A new series of technical reports has a twofold purpose: (1) to publish scientific data which is of value to many industries and institutions; (2) to acquaint readers with the company's research and engineering capabilities in optical and electronic systems. Report no. 1, "Emissivity Enhancement of Solar Cells for Temperature Control," discusses various techniques for coating these cells in order to increase cell efficiency by reradiating heat and reducing operating temperature when they are exposed to direct sunlight. Major sections of the 11-page report are devoted to construction of coating, emissivity, solar absorptivity, reflectance, and temperature determination. Several pages of charts and diagrams supplement the text. Dr. J. F. Hall is the author. For report no. 1, and future reports, write to *Military Products Div., Bausch & Lomb Inc., Rochester 2, N. Y.*

"Bodine Motorgram" . . .

Vol. 40, no. 5 of this publication features an article that describes how a spectrophotometer is used to make chemical analyses. Another article discusses the operation of a new high-speed electronic process capable of translating computer language, and printing or displaying the resulting information at the rate of 20,000 letters, numbers, and symbols per second. Also appearing in this issue are definitions of different terms commonly associated with fractional horsepower motors. *Bodine Electric Co., 2500 W. Bradley Place, Chicago 18, Ill.*

"Computer Characteristics Chart" . . .

A condensation of this chart appeared in a recent issue of *Business Week.* The chart catalogs the salient features of 43 United States-built general-purpose stored-program electronic digital computers. The computers are listed in order of decreasing rental, with cross-references to the manufacturers. Supplementary sheets describing new computer systems, as well as any important changes in those already listed, will be sent upon publication to those who have requested the chart. *Charles W. Adams Associates Inc., 142 The Great Rd., Bedford, Mass.*

Custom Wire Striping . . .

"A Design Engineer's Guide to Custom Wire Striping" is designed to help the engineer draw up color-coded wire specifications. The 4-page 2-color brochure covers several areas of wire striping, and lists the 100 clearest military-approved color combinations, along with the color combinations which should most seriously be avoided. Another feature of the brochure is an easily-read chart which breaks down the two most commonly used military specifications covering hook-up wire (MIL-W-76A and MIL-W-16878C). The chart relates the military part number to physical construction, temperature rating, conductor size, stranding specification, and voltage rating. As an aid to engineers requiring the cutting and stripping of MIL wire, the brochure also has a technical chart relating wire footage and number of pieces per thousand feet for lengths from ⅛ through 12 inches in 1/16-inch increments. *Alpha Wire Corp., 200 Varick St., New York 14, N. Y.*

"Silicones Solve Space-Age Problems" . . .

An 8-page reference describes a few of the many established applications for silicones in military and commercial aircraft, in missiles, and in ground support equipment. The importance silicones have attained in the air travel field is well demonstrated by the more than 25 applications detailed and illustrated in this brochure. Reasons why silicones have become such basic and vital materials are also outlined in this new reference which covers such silicone products as fluids, rubber, potting materials, sealants, and protective coatings. *Dow Corning Corp., Midland, Mich.*

"Powder Metallurgy Quarterly" . . .

The latest issue of this publication features case histories of electrical applications of powder metallurgy parts, showing that the products of this process are being used in an ever-increasing quantity and variety of application in business machines, home appliances, lighting fixtures, automobiles, computers, motors, electronics, and instruments.

The applications described illustrate parts used as conductors, solenoids, relay components, slip rings, shading coils, etc., in iron, steel, nickel-silver, bronze, and copper, and made by powder metallurgy. *Metal Powder Industries Federation, 60 E. 42nd St., New York 17, N.Y.*